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ABSTRACT

Developed to assist vocational agricultural mechanics students in learning to be tractor mechanics, this curriculum guide contains all the student competency sheets which comprise this competency-based curriculum. These competency sheets are categorized under sixteen instructional units. The first two units cover employment opportunities and general skills. The remaining fourteen units include the job competencies involved in servicing and maintaining the following elements: storage battery; ignition circuit; cooling systems; charging circuit; starting circuit; gasoline fuel system; diesel fuel system; basic engines; lubrication system; clutches; hydraulics; powertrain; differentials; and final drive. Each competency sheet provides a performance objective, performance guide, learning activities, supplemental reading, and criterion evaluation. (BM)

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Student Material

TRACTOR MECHANIC

Competency Based Education Curriculum

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U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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PREFACE

It is with the greatest pleasure that we bring you another West Virginia competency-based education (CBE) curriculum. This Tractor Mechanic curriculum was developed for West Virginia at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. The effort was coordinated by staff of the Bureau of Vocational, Technical and Adult Education.

The Bureau began advocating CBE curriculum in 1974. Since that time West Virginia has produced over 20 CBE curricula in various occupational areas. We also have a number of CBE curricula currently in the process of being developed and/or field-tested.

This Tractor Mechanic curriculum was disseminated to West Virginia teachers through workshops in the Spring of 1979. Additional copies of this curriculum are available from:

Vocational Curriculum Laboratory
Cedar Lakes Conference Center
Ripley, West Virginia 25271

I trust this curriculum will help your program. Any suggestions you may have for improving it may be sent to our state Curriculum Lab. Through this feedback we plan to continually update our materials.

Clarence E. Burdette
Assistant State Superintendent of Schools
Bureau of Vocational, Technical and
Adult Education

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STUDENT CURRICULUM

-INTRODUCTION-

This material is designed as a student Tractor Mechanic Competency Based Education Curriculum. It has been developed in order to facilitate vocational agricultural mechanics students in learning to be tractor mechanics.

These competency sheets are intended for use by both students and instructor. A teacher's guide accompanying this curriculum contains an explanation of the curriculum, a test of "Competencies, by Job Title", suggested student Self Test on additional handouts, a tool list, and a list of references to accompany the curriculum.

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4. Complete a Job Application 7

STUDENT COMPETENCY SHEET

UNIT: EMPLOYMENT OPPORTUNITIES

COMPETENCY: Look for a Job

PERFORMANCE OBJECTIVE: Given access to Dictionary of Occupational Titles, Occupational Outlook Handbook, Classified Ads section of local, regional, and statewide newspaper, Guidance Placement Office, become aware of the career opportunities and conditions in the field of agricultural mechanics.

PERFORMANCE GUIDE:

1. Check the Dictionary of Occupational Titles for agricultural mechanics job titles that interest you.
2. Check the Occupational Outlook Handbook for information relating to each of those jobs.
3. Consult the local telephone book for employers that hire employees under the job titles that interest you.
4. Make a list of the employer's name, address, and telephone number.
5. Look in the Classified Ads section of a local, regional, and statewide newspaper for employers that are looking for employees with agricultural mechanics job titles that interest you.
6. Make an appointment with the school placement officer (if one is available) or guidance person in charge of job placement. Find out what jobs in agricultural mechanics are available on the local, regional, state, and national level.
7. Visit local employers and find out what the working conditions are, distance needed to travel, employee benefits, competencies needed, and salary for the job you are interested in.

LEARNING ACTIVITIES:

1. Complete all the activities in the Performance Guide.

2. Answer the following questions:

   A. What are three job titles in the area of agricultural mechanics from the Dictionary of Occupational Titles in which you are interested?

   B. After reading the Occupational Outlook Handbook, what competencies are needed for those jobs? What is the average starting salary? Where are most jobs located? What type of working conditions would you have?

C. How many tractor mechanics related jobs can you think of? List them.

D. What are the advantages and disadvantages of the jobs that you are interested in?

3. Interview a person who is currently employed in a job related to tractor mechanics that interests you.

4. Write a case study on a person who has had at least 10 years experience in a tractor mechanic related occupation.

5. With the help of the Performance Guide, look for a job that interest you in the area of tractor mechanics.

SUPPLEMENTAL READINGS:

1. Chapter 38, General Office Practice, Third Edition, Archer, Brecker, Frakes, Stewart, McGraw-Hill Book Co., 1968.
2. Part 49, General Business for Economic Understanding, Eleventh Edition, Debrum, Haines, Malsbary, Daughtrey, Southwestern Publishing Col, 1976.

CRITERION EVALUATION: The student will have an understanding of what occupational opportunities and conditions are available in the area of agriculture mechanics. All steps in the Performance Guide will be completed to the instructor's satisfaction.

STUDENT COMPETENCY SHEET

UNIT: EMPLOYMENT OPPORTUNITIES

COMPETENCY: Write a personal data sheet

PERFORMANCE OBJECTIVE: Given access to all the important information about you, prepare a personal data sheet.

PERFORMANCE GUIDE:

1. Gather all the important information about you in the following areas:
   - A. What education you have had
   - B. What work experiences you have had
   - C. Any accomplishments or honors
   - D. Relevant personal information
   - E. Names of people who know what type of person you are
2. Assemble this information in outline form as follows:

   I. Personal Information
   Name, address, telephone number, year of birth, health, height, and weight

   II. Education
   Name and address of high school, grade level completed, agriculture mechanics subjects studied

   III. Employment
   List in order, begin with most recent and go back to your first employment. Include work done on volunteer basis. Describe briefly each job you had

   IV. Accomplishments and Honors
   Include any honors or offices held during school years in FFA or other club activities

   V. List of References
   Three names and addresses of people you feel would recommend you for employment. (Note: Always ask person first before using their name.) Include telephone numbers

LEARNING ACTIVITIES:

1. If you do not already have a social security card ask the school guidance counselor or placement officer how you can get one.

2. Develop a personal data sheet by following the steps outlined in the Performance Guide. Use instructors handout as a guide.

SUPPLEMENTAL READING: 1. Page 585, General Business for Economic Understanding, DeBrum, Haines, Malsbary, Daughtrey, Eleventh Edition, Southwestern Publishing Co., 1976.

CRITERION EVALUATION: The personal data sheet will be complete and written in a neat, orderly fashion. It will meet the instructor's approval when complete.

STUDENT COMPETENCY SHEET

UNIT: EMPLOYMENT OPPORTUNITIES

COMPETENCY: Prepare for a job interview

PERFORMANCE OBJECTIVE: Given the name of a prospective employer, prepare for a job interview.

PERFORMANCE GUIDE:

1. Write a letter of application and ask for an interview or go directly to the employer and ask for an interview.
2. Secure as much information as possible about the company and its business before the interview. Know what is made or sold, how large the business is, how many locations there are, kinds of jobs available, and qualifications necessary to perform them.
3. Get a good night's sleep before the interview.
4. Before going to the interview make sure you have taken a shower or bath, brushed your teeth, combed your hair, and put on a set of clean, neat clothes.
5. Be prompt for the interview.
6. Go alone.
7. Look pleasant.
8. Introduce yourself in a quiet, pleasant way.
9. Shake hands firmly.
10. Sit erect (if prospective employer indicates you should sit down).
11. Avoid signs of nervousness (such as tapping fingers or foot, excessive smoking, etc.).
12. Look interviewer in the eye.
13. Be ready to take a performance test if the job requires it.
14. Leave discussion of salary to the end of the interview.
15. Every interview should be followed up with a letter of appreciation.

LEARNING ACTIVITIES:

1. Develop a check list to be used before going to the interview.

2. Develop a list of things to remember at the interview. Keep this in a coat pocket or wallet, but use it only when needed.

3. Complete the handout on "Some Frequently Asked Questions During the Interview."

4. Practice with another student giving and taking interviews.

5. Check with instructor for additional handouts.

SUPPLEMENTAL READINGS:

1. Page 588, General Business for Economic Understanding, DeBrum, Haines, Malsban, Daughtery, Eleventh Edition, Southwestern Publishing Co., 1976.
2. Pages 519-521, General Office Practice, Third Edition, Archer, Brecker, Frakes, Stewart, McGraw-Hill Book Company, 1968.

CRITERION EVALUATION: The student will complete the learning activities to the instructor's satisfaction.

STUDENT COMPETENCY SHEET

UNIT: EMPLOYMENT OPPORTUNITIES

COMPETENCY: Complete job application form

PERFORMANCE OBJECTIVE: Given a job application and a ballpoint pen or pencil, complete the application form.

PERFORMANCE GUIDE:

1. Read the application form carefully before filling it out.
2. Fill out all the blanks that apply to you.
3. Either print or write as directed, never use both.
4. Use either a pen or a clear writing pencil. (NOTE: Never use both.)
5. Do not use abbreviations.
6. Be neat, accurate, and honest with all information.
7. Signature is always written.
8. Do not write in blanks that are to be used by the company.

LEARNING ACTIVITIES:

1. Locate the following information needed to successfully complete a job application form:

   A. Personal Data
      (1) Date of Birth (DOB)
      (2) Plate of Birth (POB)
      (3) Social Security Number (SSN)
      (4) Telephone number including area code
      (5) Residence
      (6) Marital status
      (7) Picture (if requested)
   B. Educational Information
      (1) High school credits
      (2) Courses taken
      (3) Class rank
      (4) Co-curricular activities
      (5) Extra curricular activities
      (6) Special awards and recognitions
   C. Military Information
   D. Previous Employment

2. Take the student self test supplied by your instructor.

3. Fill out an application form provided by the instructor or employer. Use the Performance Guide whenever needed.

SUPPLEMENTAL READINGS:

1. Pages 585-588, General Business for Economic Understanding, DeBrum, Haines, Malsbary, Daughtrey, Eleventh Edition, Southwestern Publishing Co., 1976.
2. Pages 522-523, General Office Practice, Third Edition, Archer, Brecker, Frakes, Stewart, McGraw-Hill Book Company, 1968.

CRITERION EVALUATION: The directions printed on the application form will be completed with 100% accuracy. All information filled in on the application will be spelled correctly, appear in a neat form, and meet the instructor's approval.

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3. Check Torque Converter with Test Equipment 11

4. Inspect New Tractor Parts for Shipping Damage 13

5. Prepare Tractor for Steam Cleaning 14

6. Clean Tractor with Steam Cleaner 15

7. Prepare Steam Cleaner for Shutdown 16

8. Prepare Tractor for Painting 17

9. Paint Tractor 18

10. Repair Brake Assemblies 19

11. Service Air Cleaner (Oilbath) 21

12. Service Air Cleaner (Dry) 23

13. Service Drive Shafts 25

14. Service an Engine Governor 26

15. Service Hydraulic Governor (Diesel) 28

16. Service Power Take-Off Drive 30

17. Service Special Drives (Belt, Chain, Gear and Variable Speed) 32

18. Service Universal Joints 34

19. Test Engine Compression 36

20. Use the Dynamometer 37

STUDENT COMPETENCY SHEET

UNIT: PERFORMING GENERAL SKILLS

COMPETENCY: Adjust wheel bearings

PERFORMANCE OBJECTIVE: Given a basic mechanic's tool set, jack, and safety stand, manually adjust the wheel bearings on an assigned tractor.

PERFORMANCE GUIDE:

1. Raise tractor with jack; place safety stand under axle.
2. Remove dust cover with lock-joint utility pliers.
3. Remove cotter pin.
4. Rotate (spin) wheel.
5. Tighten nut until slight resistance is felt.
6. Back off nut to nearest cotter pine hole.
7. Spin wheel to test for free rolling.
8. Shake wheel from side to side to test for looseness.
9. Install new cotter pin.
10. Replace dust cover.

LEARNING ACTIVITIES:

1. Read pages 114-119, Tractor Maintenance, AAVIM, 1975.

2. Read pages 169-173, Fundamentals of Machine Operation - Preventive Maintenance.

3. Answer the following questions:

   A. Why should you be careful and avoid getting dirt on any bearing parts?

   B. Explain the difference between adjusting the bearing on a spindle-type wheel and adjusting the bearings on an axle-type wheel.

   C. Explain what it means to test a wheel for "free rolling."

4. Adjust the wheel bearings on the assigned tractor with the help of the Performance Guide.

CRITERION EVALUATION: The adjusted wheel should roll freely with no loose motion.

STUDENT COMPETENCY SHEET

UNIT: PERFORMING GENERAL SKILLS

COMPETENCY: Check tires for pressure, wear, and defects

PERFORMANCE OBJECTIVE: Given a tractor with worn and damaged tires, jack, and tire gauge, check the tires for proper inflation and visually examine tires for wear and defects.

PERFORMANCE GUIDE:

1. Raise tractor to permit rotation of tires.
2. Use standard pressure gauge to measure PSI. (Place valve stem at top of rotation to test fluid filled tires.)
3. Inflate to PSI as indicated by tire manufacturer.
4. Visually inspect tires for defects, tread and sidewall cuts, fabric breaks, rebber checks, stubble wear, valve damage, and tread wear.

LEARNING ACTIVITIES:

1. Read pages 39-43, Tractor Maintenance, AAVIM, 1975.

2. Read pages 179-183, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

3. Complete the following questions:

   A. What will happen to tractor tire if it is over-inflated? under-inflated?
   B. What are 4 rules that must be observed for proper tire inflation?
   C. List 4 steps to follow when checking tire inflation.
   D. Tire failures may be caused by _____, _____, _____, or just plain _____ _____.
   E. Why should you always wash a tire gauge with clear water after using it on a tire containing calcium-chloride solution?

4. Check tires on the designated tractor for proper inflation and identify any defects and wear.

SUPPLEMENTAL READING:

1. Pages 36-37, Tractor Operation and Daily Care, AAVIM, 1978.

CRITERION EVALUATION: Tire pressure will be 100% accurate as indicated in the manufacturer's specifications and all defects identified.

STUDENT COMPETENCY SHEET

UNIT: PERFORMING GENERAL SKILLS

COMPETENCY: Check torque converter with test equipment

PERFORMANCE OBJECTIVE: Given wrenches to fit bolts encountered, shop manual, a pressure gauge 0-500 PSI, and fittings to hook gauge to tractor, check the torque converter with the test equipment.

PERFORMANCE GUIDE:

NOTE: The following steps for checking a torque converter are given for a Case 530 with a twin-disc converter. The checks on other converters are much the same except for checking location differences.

1. Check operator's manual for correct pressures and checking points.
2. Start engine and bring transmission oil temperature up to normal operating range.
3. Depress pressure-release pedal; pressure on dash should drop to zero.

NOTE: If difficulty is encountered, the clutches are not releasing or linkage is adjusting incorrectly. If customer complaint is lack of power, a pressure check is indicated.

4. Check main pressure by removing the torque converter filter to oil cooler line and install a 500 PSI test gauge.
5. Run engine just long enough to read pressure and shut down engine. Compare reading with specifications given by manufacturer. Reconnect lines after removing gauge.
6. If reading is within specifications, remove the plate for checking the clutch pressure and install gauge there.
7. Run tractor, and release foot lever. Compare this reading with manufacturer's specifications.
8. Pull direct-drive lever and check pressure. Pressure should drop momentarily and then return to former position.
9. If any of these tests are not found to be specifications, check central linkages. If the source of the problem is not found through these tests, the torque converter will have to be replaced.

LEARNING ACTIVITIES:

1. Read Chapter 6, Fundamentals of Service-Powertrains, Deere and Co., Moline, Ill., 1972, and answer the following questions:

   A. What is a torque converter and what does it do?
   B. Acting as a _____, the torque converter connects and disconnects power between the engine and gear.
   C. As a _____ the converter gives many more speed ratios than are practical with a strictly mechanical gear box.
   D. What are 5 rules to follow in order to help prevent torque converter failures?
   E. Describe how you can use your eyes, ears, and nose to head off trouble before serious damage is done to a torque converter.
   F. List and explain four common areas of trouble with a torque converter.

2. Read page 134, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

3. Check in the owner's manual for correct pressures and checking points.

4. Check the torque converter with test equipment specified for the designated tractor.

SUPPLEMENTAL READINGS:
1. Pages 88 and 91, Tractor Operation and Daily Care, AAVIM, 1970.
2. I&T Shop Manual, Technical Publications, Inc., Kansas City, Mo.

CRITERION EVALUATION: The gauge readings will be within 5% of the instructor's readings.

STUDENT COMPETENCY SHEET

UNIT: PERFORMING GENERAL SKILLS

COMPETENCY: Inspect new tractor parts for shipping damage

PERFORMANCE OBJECTIVE: Given an unopened box of tractor parts, open the box and inspect contents for damage.

PERFORMANCE GUIDE:

1. Open package using tools that will not damage contents.
2. Remove and read packing list.
3. Check that all parts listed on the packing slip are there.
4. Remove each part and inspect for damage that would prohibit its proper function. (broken, dented, scratched, bent, etc.)
5. Return damaged parts to supplier.
6. Put usable parts in appropriate storage or to use.

LEARNING ACTIVITIES:

1. Open a box of tractor parts and perform a visual inspection for damaged and missing parts.

CRITERION EVALUATION: All accepted parts should show no damage.

STUDENT COMPETENCY SHEET

UNIT: PERFORMING GENERAL SKILLS

COMPETENCY: Prepare steam cleaner for use

PERFORMANCE OBJECTIVE: Given a steam cleaner, power source, and water supply, prepare the steam cleaner for use.

PERFORMANCE GUIDE:

1. Visually inspect machine for soundness of parts.
2. Attach water hose and power cord.
3. Replace drain plug if needed.
4. Check fuel and refill.
5. Turn on fuel and power source.
6. Start pump.
7. Uncoil steam hose.
8. Start burner when water runs out of nozzle.
9. Add soap.

LEARNING ACTIVITIES:

1. Demonstrate to the instructor your ability to complete all of the steps in the Performance Guide when preparing the steam cleaner for use.

CRITERION EVALUATION: The preparation must include acceptable completion of all the steps in the Performance Guide.

STUDENT COMPETENCY SHEET

UNIT: PERFORMING GENERAL SKILLS

COMPETENCY: Clean tractor with steam cleaner

PERFORMANCE OBJECTIVE: Given a dirty tractor and a steam cleaner prepared for use, clean the tractor.

PERFORMANCE GUIDE:

1. Remove tractor hood, muffler, and air breather.
2. Cover exhaust and intake openings.
3. Apply degreaser to heavy grease and oil deposits.
4. Secure protective clothing, gloves, and safety face shield.
5. Hold end of nozzle 8" to 10" from tractor.
6. Move nozzle in back-and-forth motion parallel to tractor surface.
7. Avoid steaming of areas such as starter, generator, etc.
8. Continuously check functioning of steam cleaner.
9. Clean all areas of tractor; use soap for the first application, finish with steam only.

LEARNING ACTIVITIES:

1. Read pages 129-131, Tractor Maintenance, AAVIM, 1975, and complete the following questions.

   A. List 5 reasons for regular tractor cleaning.
   B. What procedure would you follow for using de-greasers, diesel fuel or kerosene when cleaning your tractor?

2. Read pages 204-205, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

3. In a well ventilated area of the laboratory, clean a tractor with the steam cleaner.

CRITERION EVALUATION: Upon inspection the tractor should show no signs of dirt, oil, or grease.

STUDENT COMPETENCY SHEET

UNIT: PERFORMING GENERAL SKILLS

COMPETENCY: Prepare and shut down the steam cleaner

PERFORMANCE OBJECTIVE: Following the use of the steam cleaner, prepare the cleaner for shut down.

PERFORMANCE GUIDE:

1. Shut off burner.
2. Allow pump to run until water coming from nozzle is cool.
3. Shut off pump and water supply.
4. Disconnect water and power supply.
5. Drain.
6. Clean up and put away steam cleaner and cleaning materials.

LEARNING ACTIVITIES:

1. Demonstrate to the instructor your ability to prepare and shut down the steam cleaner.

CRITERION EVALUATION: The preparation must include acceptable completion of all the steps in the Performance Guide.

STUDENT COMPETENCY SHEET

UNIT: PERFORMING GENERAL SKILLS

COMPETENCY: Prepare tractor for painting

PERFORMANCE OBJECTIVE: Using the necessary repair tools, needed repair parts, and paint materials, prepare tractor for painting.

PERFORMANCE GUIDE:

1. Hammer out dents, fill and smooth body putty. ("bondo," etc.)
2. Sand rough areas with jitterbug orbital sander and sandpaper; steam clean all areas to be painted.
3. Mask areas not to be painted with masking tape.
4. Prime bare spots.
5. Make minor repairs.
6. Bathe surface with demagnetizing solution.
7. Set up tractor in paint room.

LEARNING ACTIVITIES:

1. With the help of the Performance Guide, prepare a tractor for painting. This should be done in the paint area of the shop.

SUPPLEMENTAL READING:

1. Chapter 11, Mechanics in Agriculture, Lloyd J. Phipps, Second Edition, 1977, The Interstate Printers and Publishers, Inc.

CRITERION EVALUATION: Upon completion, all dents will be hammered out and smoothed over with body putty. All areas not to be painted will be masked with tape. All bare spots will be primed, and the entire surface will have been bathed in a demagnetizing solution before painting.

STUDENT COMPETENCY SHEET

UNIT: PERFORMING GENERAL SKILLS

COMPETENCY: Paint tractors

PERFORMANCE OBJECTIVE: Given a tractor set-up in a paint room, gun, respirator, and compressed air source, paint the tractor.

PERFORMANCE GUIDE:

1. Check room to proper temperature and humidity levels.
2. Set up paint gun.
3. Set air pressure.
4. Turn on exhaust system.
5. Thin paint if needed.
6. Fill gun reservoir through strainer.
7. Put on respirator.
8. Adjust gun.
9. Paint tractor.
10. Clean gun.
11. Put away equipment.
12. Do not move tractor until paint is dry.

LEARNING ACTIVITIES:

1. Read pages 210-212, Mechanics in Agriculture, Lloyd J. Phipps, Second Edition, 1977, The Interstate Printers and Publishers, Inc., and complete the following questions:

   A. What tools are required for spray painting?
   B. How far should you hold the spray gun from the painting surface when painting?
   C. Why should you always hold the spray gun at 90 degrees from the painting surface when painting?
   D. Describe how you would clean the spray gun.

2. In the paint area of the shop, paint the tractor.

SUPPLEMENTAL READING:

1. Chapter 12, Farm Mechanics, Phipps, McColly, Scranton, Cook, 1954, The Interstate Printers and Publishers.

CRITERION EVALUATION: The completed paint job should be smooth, glossy, and with only minor runs.

STUDENT COMPETENCY SHEET

UNIT: PERFORMING GENERAL SKILLS

COMPETENCY: Repair brake assemblies

PERFORMANCE OBJECTIVE: Given rebuilt brake shoes, a service manual, jack wheel blocks, solvents and rags, replacement parts, a mechanic's tool set and a brake tool set, repair a brake assembly.

PERFORMANCE GUIDE: NOTE: There are several types of brake assemblies. Check manufacturer's service manual for specific details.

1. Block wheels.
2. Jack up tractor and remove wheel.
3. Pull off brake drum.
4. Remove shoe retainers.
5. Remove shoes.
6. Clean all parts and inspect for excessive wear.
7. Replace shoes with rebuilt shoes.
8. Replace all worn parts as necessary.
9. Reinstall shoes and hardware including return springs, adjusting mechanism and shoe retainers.
10. Reinstall drum. (Have drum turned if deeply grooved.)
11. Reinstall wheel.
12. Adjust brake shoes to manufacturer's specifications.
13. Repeat procedure for other wheel.

LEARNING ACTIVITIES:

1. Read pages 175-178, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973, and complete the following questions:

   A. List and describe three methods that provide braking action.
   B. What are two things that can indicate when brakes need adjustment or repair?
   C. Describe the steps that you would use when adjusting the brakes after you have replaced the worn parts.

2. Read pages 80-82, Tractor Maintenance, AAVIM, 1975.

3. Check the operator's manual or Farm Tractor Tune-Up and Service Specification for the amount the brakes should be tightened for your tractor.

4. Repair the brake assembly on the assigned tractor with the help of the Performance Guide and service manual.

CRITERION EVALUATION: All parts will be clean, back in place and the brakes will be adjusted to specifications.

STUDENT COMPETENCY SHEET

UNIT: PERFORMING GENERAL SKILLS

COMPETENCY: Service air cleaner (oilbath)

PERFORMANCE OBJECTIVE: Given a tractor equipped with oil-type air cleaner, operator's manual, necessary tools and supplies, service an oil-type air cleaner.

PERFORMANCE GUIDE:

1. Loosen oil cup and remove from filter.
2. Check depth of sediment deposit in outer chamber.
3. Discard dirty oil. Scrape and wash inner and outer cups with clean kerosene, mineral spirits, or diesel fuel.
4. Check air-intake pipe for dirt accumulation. Clean if needed.
5. Refill cup with clean oil of recommended viscosity to oil level mark.
6. Replace oil cup and screen tray; tighten clamp.
7. Check air duct between cleaner and carburetor for holes or loose clamp connections. Tighten clamps or replace duct as needed.
8. Check air-inlet screen or precleaner and remove any trash that is found.

LEARNING ACTIVITIES:

1. Read pages 6-6 to 6-8, Fundamentals of Service-Engines, and complete the following questions:

   A. Why must oil bath air cleaners be properly maintained?
   B. What will happen if the air flow through the air cleaner is restricted?
   C. What will happen if dirty air goes directly to the engine cylinder?
   D. List 6 good maintenance rules for good air cleaner operation.
   E. What steps would you use in servicing an oil bath air cleaner?
   F. Why should you never attempt to clean the element with a steam cleaner?

2. If the instructor directs, read pages 132-134, part 5, Tractor Maintenance, AAVIM, and answer the following questions:

   A. What are the nine steps to cleaning an air cleaner assembly?
   B. When can you omit steps 3, 4, 5, and 6?
   C. When should you include steps 3, 4, 5, and 6?

3. Service the air cleaner by using the Performance Guide.

SUPPLEMENTAL READINGS:

1. Chapter 2, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1972.
2. Pages 5-7, Tractor Operation and Care.

CRITERION EVALUATION: The oil bath air cleaner will be correctly installed with clean oil of recommended viscosity. The outer and inner cups will be free of any sediment deposit when the job is complete.

STUDENT COMPETENCY SHEET

UNIT: PERFORMING GENERAL SKILLS

COMPETENCY: Service air cleaner (dry-type)

PERFORMANCE OBJECTIVE: Given a tractor equipped with dry-type air cleaner, operator's manual, necessary tools, dry-type filter, and rags, service a dry-type air cleaner.

PERFORMANCE GUIDE:

1. Stop engine, if it is running.
2. Squeeze dust unloader if supplied on your air cleaner. (NOTE: Some tractors are equipped with a connection to the engine exhaust system which will automatically unload the dirt from the pre-cleaner.
3. Remove the hood or grill, if necessary, to provide access to air cleaner unit.
4. Wipe off dust accumulated around end of cleaner where element will be removed.
5. Loosen hand screw or clamp that holds the end cap on the end of the cleaner and remove cap.
6. Clean the area around the element and clean the dust cap and baffle on air cleaner having end caps. (NOTE: Use a dry clotch. Don't use gasoline, fuel oil or solvents.
7. Remove filter element from cleaner.
8. Check condition of rubber gasket on end of filter element.
9. Tap filter element to loosen dirt, but gently enough that element is not damaged.
10. Rotate element during tapping procedure and shake out dust.
11. Replace the filter element in the cleaner.
12. Tighten with fingers the wing nut that holds the element in place.
13. Complete remaining procedures in reverse order from those used to remove the filter.

LEARNING ACTIVITIES:

1. Read pages 21-26, Tractor Maintenance, AAVIM, 1975.

2. Read pages 6-2 to 6-3, 6-6 to 6-9, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

3. Complete the following questions:

   A. Why is an air cleaner important?
   B. List three of the most common type air cleaners.
   C. What are six maintenance rules for good air cleaner operation?
   D. When are three occasions when you should replace the filter element?

SUPPLEMENTAL READINGS:

1. Pages 9-16, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.
2. Pages 3-7, Tractor Operation and Daily Care, AAVIM, 1970.

CRITERION EVALUATION: The air cleaner will be clean, a new element correctly installed and the dust unloader will have been emptied upon complete of service.

STUDENT COMPETENCY SHEET

UNIT: PERFORMING GENERAL SKILLS

COMPETENCY: Service drive shafts

PERFORMANCE OBJECTIVE: Using the designated tractor, the manufacturer's service manual, shop rags, lubricants, and the necessary tools, service the drive shafts.

PERFORMANCE GUIDE:

NOTE: There are two basic types of drive shafts - solid shafts and telescoping shafts. Check service manual for specific tractor.

1. Shut off engine and disengage all power (esp. PTO).
2. Remove all parts necessary to reach drive shaft.
3. Clean off visible dirt with shop rag and lubricate the drive line in the following three ways:
   a. Lubricate the telescoping drive shafts. (if available on the model). Check to be sure PTO drive shaft is secured to the machine PTO shaft.
   b. Inspect and lubricate the bearings, replacing same if bearings are worn or faulty.
   c. Inspect and lubricate the universal joints.
4. Reassemble all parts removed and re-engage power.

LEARNING ACTIVITIES:

1. Read page 9-2, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill.

2. Check the I&T Shop Manual for instructions in removing all parts necessary to reach drive shaft.

3. Service the drive shafts on the designated engine.

SUPPLEMENTAL READING: 1. Page 134-137, Tractor Maintenance, AAVIM, 1975.

CRITERION EVALUATION: All parts will be clean and lubricated with the recommended lubricant, and there will be no damage to any parts.

STUDENT COMPETENCY SHEET

UNIT: PERFORMING GENERAL SKILLS

COMPETENCY: Service an engine governor

PERFORMANCE OBJECTIVE: Given a mechanic's tool set, shop manuals, replacement parts, and gasket compound, service an engine governor.

PERFORMANCE GUIDE:

1. Test engine governor for functioning.
   a. With carburetor adjusted and ignition set correctly, the engine should idle smoothly. If it does not, it probably means the governor is faulty.
   b. Engine should operate smoothly under load. If engine surges, a faulty governor is indicated.
2. Remove governor, if faulty, and disassemble.
3. Replace all worn parts and install new gaskets.
4. Reassemble and install governor.
5. Test for proper functioning.

LEARNING ACTIVITIES:

1. Read Chapter 9, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972, and complete the following questions:

   A. What is a governor?
   B. What are three jobs a governor can do?
   C. What are the two most common types of throttle governors?
   D. What is the difference between a "variable speed" governor and an "over speed" governor?
   E. What is speed droop?

2. Listed below are a few of the symptoms of governor problems. List the possible causes and the possible remedies. Use the above recommended reading for help.

   A. Erratic engine operation, hunting or misfiring
   B. Engine idles erratically
   C. Engine not receiving fuel
   D. Engine does not develop full power or speed

3. Read pages 143-145, Tractor Maintenance, AAVIM, 1975.

4. Consult the I&T Shop Manual, for the correct procedure when disassembling the governor.

5. Service the engine governor on the designated tractor with the help of the performance guide.

SUPPLEMENTAL READING:

1. Pages 51-54, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

CRITERION EVALUATION: All worn parts will be replaced and the governor will function properly.

STUDENT COMPETENCY SHEET

UNIT: PERFORMING GENERAL SKILLS

COMPETENCY: Service hydraulic governor (diesel)

PERFORMANCE OBJECTIVE: Using a diesel engine having a faulty hydraulic governor, follow the instructions in the manufacturer's service manual to service the governor.

PERFORMANCE GUIDE:

1. Follow directions in manufacturer's service manual for complete instructions.
2. Check for erratic engine operation, misfiring or hunting:
   a. Governor idle spring is missing or adjusted incorrectly--replace or adjust spring.
   b. Governor control spring is worn or broken--remove and replace.
   c. Governor is not operating because of worn parts, binding, sticking, or is incorrectly assembled--check service manual, disassemble, inspect, replace parts if necessary.
   d. Governor spring is incorrect--remove to replace with correct spring.
   e. Governor high idle adjustment is incorrect--adjust governor to diesel pump specifications.
   f. Governor adjusting screw is not adjusted--adjust.
3. If engine does not receive fuel, check for worn, sticking, binding, or incorrect assembly. Take apart and repair or replace.
4. If engine idle speed is faulty, check to see if:
   a. Governor idle spring is missing or adjusted incorrectly--replace or adjust.
   b. Governor not operating because of worn, binding, sticking or incorrect assembly--disassemble and repair or replace parts.
   c. Wrong or extended governor spring--remove and replace.
5. If engine does not develop full power or speed, check to see if:
   a. Governor not operating due to worn, binding, or sticking parts, or incorrect assembly--take apart and repair or replace.
   b. Incorrect governor spring--remove and replace.
   c. Improper adjustment of adjusting screw--adjust governing screw.
6. Clean all parts as recommended in the service manual and reassemble and check following instructions in the service manual.

LEARNING ACTIVITIES:

1. Read Chapter 9, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972. Answer all of the questions at the end of the chapter.

2. Read pages 143-145, Tractor Maintenance, AAVIM, 1975.

3. Following the directions in the I&T Shop Manual or manufacturer's service manual for complete instructions when disassembling, cleaning, and reassembling the governor.

4. Service the hydraulic governor, with the help of the Performance Guide, on the designated engine.

SUPPLEMENTAL READINGS:

1. Pages D-213-E to D-234-E, Diesel Engine Mechanics, William A. Foutes, Mid-America Vocational Curriculum Consortium, Inc., 1977.
2. Pages 52-54, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

CRITERION EVALUATION: When service is completed, the governor will operate according to manufacturer's specifications.

STUDENT COMPETENCY SHEET

UNIT: PERFORMING GENERAL SKILLS

COMPETENCY: Service power take-off drive

PERFORMANCE OBJECTIVE: Given a tractor with power take-off drive and necessary tools and supplies, service the power take-off drive.

PERFORMANCE GUIDE:

1. Set wheel brakes.
2. Disengage power to power take-off shaft.
3. Shut off engine.
4. Remove cap from end of power take-off shaft.
5. Check tractor power take-off shaft to determine shaft speed.
6. Check to determine if splined coupling on machine is connected to power take-off.
7. Check inside spline of universal joint for foreign matter and dirt.
8. Clean and oil outside spline of tractor power shaft.

LEARNING ACTIVITIES:

1. Read Chapter 9, Fundamentals of Service-Powertrains, and complete the following questions:

   A. What are the three basic types of PTO's?
   B. What are the two speeds offered by a typical PTO?
   C. One way of telling two PTO shafts - 540 and 1000 RPM - apart is that the 540 RPM shaft has _____ splines while the 1000 RPM shaft has _____ splines.
   D. What are 10 safety rules for operation of PTO's?

2. Read pages 68-74, Tractor Operation and Daily Care, AAVIM, 1970 and complete the following questions:

   A. Why should you always check the spline coupling on a machine with the tractor PTO spline before completing the coupling process?
   B. How would you clean and oil the outside spline of a tractor power shaft?

3. After completing the above check with the instructor, use the Performance Guide as an aid in servicing a power take off drive.

SUPPLEMENTAL READINGS:

1. I&T Shop Manual.
2. Page 136, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1972.

CRITERION EVALUATION: The student will have completed the following in an acceptable manner:

1. Prepare tractor for service of PTO.
2. Determine PTO shaft speed
3. Check splined coupling on machine for proper connections to power take off.
4. Clean and oil outside spline.

STUDENT COMPETENCY SHEET

UNIT: PERFORMING GENERAL SKILLS

COMPETENCY: Service special drives (belt, chain, gear, and variable speed)

PERFORMANCE OBJECTIVE: Given service manuals for specific drives, solvents, lubricants, and the needed tools, service the special drives on the designated tractor.

PERFORMANCE GUIDE:

1. Belt drives. (Note: There are three basic types of belt drives--flat belts, V-belts, and round belts. These may be made of leather, rubber, fabric, steel, wire, or in combinations. They may take an opened, turned, crossed, serpentine or mule forms.)
   a. Check for signs of improper installation (belt stretches beyond take-up, fails for no visible reason, turns over, cut on bottom, creeps or slips). Replace or adjust.
   b. Check condition of pulleys and smooth or adjust as needed.
   c. Check belt alignment and tension. Adjust to specifications.
   d. Clean belt of oil and grease with cloth and solvent. Add belt dressing if recommended by manufacturer.
   e. Clean belt shields and screens.
2. Chain drives. (Note: There are three basic types of chains--plain, roller, and silent.)
   a. Remove connector link and clean chain in solvent. Lubricate.
   b. Clean driving sprocket, driver sprocket, and adjustable idler sprocket with brush and solvent. Lubricate.
   c. With connector link removed, wrap chain around sprockets bringing free ends together on one sprocket and install connector link. Tap chain pin links back so that fasteners are snug against the connecting link plate.
   d. Adjust chain tension on adjustable idler sprocket.
3. Gear drives: Check manufacturer's manual for type of lubricant.
   a. Open gears can be lubricated by:
      1. Splash pan which gears run through
      2. Hand lubrication by brushing or squirting.
      3. Use of a drip oiler.
   b. Check gear for excessive wear, breaks or cracks and replace if necessary.

4. Variable speed gears are variations on the above gears. Follow instructions given here and in the service manual.
   a. Clean.
   b. Lubricate if indicated.
   c. Adjust tension.

LEARNING ACTIVITIES:

1. Read pages 187-195, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

2. Read pages 15-17, Tractor Maintenance, AAVIM, 1975.

3. Complete the following questions:

   A. List 5 symptoms of V-belt wear, their causes and remedies.
   B. Describe how you would check V-belt tension.
   C. Why is chain tension vital to the proper operation of chain drives?
   D. List 6 steps you should use when adjusting the chain tension.
   E. _____ of chains is perhaps the most important factor in long service life.
   F. Describe the steps needed for chain installation.
   G. Name three types of common gears and the recommended gear lubricant for each.
   H. What are three kinds of gear adjustment?

4. Service the special drives on the designated tractor with the help of the performance guide.

SUPPLEMENTAL READINGS:
1. Chapter 26, Mechanics in Agriculture, Lloyd J. Phipps, Second Edition, The Interstate Printers and Publishers, Inc., Danville, Ill.
2. Chapter 30, Farm Mechanics Text and Handbook, Phipps, McColly, Scranton, and Cook, 1954, The Interstate Printers and Publishers, Inc., Danville, Ill.
3. Fundamentals of Service-Belts and Chains, Deere and Co., Moline, Ill., 1972.

CRITERION EVALUATION: All parts will be clean, lubricated, and adjusted to specified tension in service manual.

STUDENT COMPETENCY SHEET

UNIT: PERFORMING GENERAL SKILLS

COMPETENCY: Service a universal joint

PERFORMANCE OBJECTIVE: Given new parts as needed, lubricant, a manufacturer's service manual, and the necessary tools, service a universal joint.

PERFORMANCE GUIDE:

1. Note position of grease fittings (if used) and mark the yoke in relation to the propeller shaft for reassembly purposes later.
2. Remove retainer plates (or snap rings) that hold bearings in yoke and drive shaft.
3. Place universal joint in a vise. Select a wrench socket with an outside diameter and slightly smaller than universal joint bearings, and select another wrench socket with an inside diameter slightly larger than the universal joint bearings. Place sockets at opposite bearings in the yoke so that the smaller socket becomes a bearing pusher and the larger becomes a bearing receiver.
4. Close vise jaws until both bearings are free of the yoke, and remove bearings from the cross or spider. (A hydraulic press may also be used.)
5. Check service manual for detailed instructions if bearings will not come all the way out.
6. Remove yoke from drive shaft and press bearings out of the drive shaft.
7. Clean and examine all parts, replacing parts with damage or excessive wear. (If old parts are to be reassembled, pack bearing cups with universal joint grease. If new parts are being installed, check new bearings for adequate grease.) Use new seals.
8. With pusher socket, press one bearing part way into drive shaft. Position spider into partially installed bearing and place second bearing into drive shaft.
9. Put drive shaft in vise so that bearings are in contact with faces of vise jaws.
10. Press bearings into position and install snap rings or retainer plates.
11. Install bearings in yoke in same manner. Check universal joints for roughness and binding, and correct the condition if necessary prior to installation in tractor.

LEARNING ACTIVITIES:

1. Read pages 9-3 to 9-4, Fundamentals of Service-Powertrains, and answer the following questions:

A. What does a universal joint do?
B. What is the most common type of universal joint?
C. List the parts that make up a universal joint and be able to identify them.

2. With the help of a manufacturer's service manual, service a universal joint on the designated tractor.

NOTE: The three common types of universal joints are (1) cross and roller, (2) ball and trunnion, and (3) constant velocity. There are several variations on each type. Check manufacturer's service manual for specific details.

CRITERION EVALUATION: There will be no damage to any parts, new bearings and seals will be installed, and there will be no roughness or binding in the new bearings and seals.

STUDENT COMPETENCY SHEET

UNIT: PERFORMING GENERAL SKILLS

COMPETENCY: Test engine compression

PERFORMANCE OBJECTIVE: Given a compression tester and a spark-plug wrench, test the compression on an engine.

PERFORMANCE GUIDE:

1. Run the engine until normal operating temperature is reached.
2. Remove all spark plugs.
3. Open throttle all the way.
4. Place the gauge in one spark plug hole.
5. Crank the engine until no more rise in pressure on the gauge is apparent.
6. Record the compression reading.
7. Repeat for each spark plug hole.
8. Check specifications for compression.
9. If low pressure appears, add 1 tsp. of oil to each cylinder and repeat test.

LEARNING ACTIVITIES:

1. Read pages 12-11 and 12-12, Fundamentals of Service-Engines and answer each of the following questions:

   A. What is a result of weak engine compression?
   B. List nine steps that you should follow when doing a compression test.
   C. Describe how compression affects engine performance.
   D. List ten causes of poor compression.

2. Look in the appropriate I&T Shop Manual to find the correct compression and cranking speed for the tractor you will be working on.

3. Obtain a compression tester and a spark-plug wrench, test the compression on the designated tractor with the help of the Performance Guide.

SUPPLEMENTAL READINGS:

1. Page 27, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.
2. Page 12-14, Tractor Engine Tune-Up, West Virginia University publication.

CRITERION EVALUATION: Student readings should be within $\pm$ 5% of the instructor's readings.

STUDENT COMPETENCY SHEET

UNIT: PERFROMING GENERAL SKILLS

COMPETENCY: Use the dynamometer

PERFORMANCE OBJECTIVE: Given a dynamometer complete with operating instructions, the manufacturer's service manual for the tractor to be tested and any tools needed, test the horsepower, exhaust, fuel consumption, and crankcase blow-by on the designated tractor.

PERFORMANCE GUIDE:

1. Following manufacturer's instructions, connect the dynamometer to the machine.
2. Operate the engine for 30 minutes at one-half load to get coolant and crankcase oil temperatures up to normal.
3. Increase the load on the engine gradually until the speed is reduced to the rated load speed given in the manufacturer's service manual, and take reading of the horsepower on the dynamometer.
4. Compare reading with that given in the service manual.
5. Following manufacturer's instructions test for: exhaust analysis, smoke analysis, diesel, and carburetor adjustment (spark-ignition), and crankcase blow-by.

NOTE: If indicated, tune-up or overhaul the engine by following instructions in the service manual.

Use the dynamometer after tune-up or overhaul to determine horsepower output and fuel consumption.

LEARNING ACTIVITIES:

1. Read pages 209-212, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

2. Read pages 11-4 to 11-5, 12-3, 12-23 to 12-24, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

3. Complete the following questions:

   A. What are three things that good engine performance depend on?
   B. Should you always expect your engine to equal the specifications given in a technical manual? How much can they differ?
   C. List the 9 operations a dynamometer can test.

4. Check I&T Shop Manual for your engines specifications needed when using a dynamometer.

5. Test the horsepower, exhaust, fuel consumption and crankcase blow-by on the assigned tractor using a dynamometer.

SUPPLEMENTAL READING:

1. Diesel Engine Mechanics, William A. Foutes, Mid-America Vocational Curriculum Consortium, Inc., 1977.
2. Pages 339-341, Diesel and High Compression Gas Engines, E. J. Kates and W. E. Luck, Third Edition, American Technical Society, 1975.

CRITERION EVALUATION: The dynamometer will be connected according to manufacturer's instructions and the student's readings will agree with those of the instructor.

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STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING STORAGE BATTERY

COMPETENCY: Activate dry-charged batteries

PERFORMANCE OBJECTIVE: Given a dry-charged battery, electrolyte, service manual, protective equipment, battery syringe or manufacturer's dispenser, and a battery charger, activate the battery.

PERFORMANCE GUIDE:

1. Remove battery from box.
2. Remove caps from battery cells.
3. Fill battery cells with electrolyte using battery syringe.
4. Slow charge the battery for 4-6 hours in well-ventilated area.
5. Clean and replace battery caps. (Make sure vent holes are clear.)
6. Measure battery voltage with a voltmeter.

LEARNING ACTIVITIES:

1. Read page 3-6, Fundamentals of Service - Electrical Systems, Deere and Co., Moline, Ill., and complete the following questions:

   A. What is a "dry-charged battery"?
   B. Where should dry-charged batteries be stored? Why?
   C. What is the advantage of dry-charged batteries? Disadvantage?
   D. Why should you slow charge a freshly activated battery?
   E. Should you add acid after charging the dry-charged battery?

2. Read pages 10-14, Tractor Maintenance, AAVIM, 1975.

3. Read pages 424-426, Mechanics in Agriculture, Lloyd J. Phipps, Second Edition, 1977, The Interstate Printers and Publishers, Danville, Ill.

4. Observe filmstrip, Fleet Battery Care, Delco-Remy.

5. Activate a dry-charged battery in the shop area.

SUPPLEMENTAL READINGS:

1. Pages 48-50, Agricultural Machinery Tractor Engine Tune-Up, W. VA. Publication, 1973.
2. Pages 92-102, Fundamentals of Machine Operation - Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

CRITERION EVALUATION: The electrolyte will be 3/8 inch above the plates. The reading on the voltmeter will be within one volt of the measurement obtained by the instructor.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING STORAGE BATTERY

COMPETENCY: Charge a wet-cell battery.

PERFORMANCE OBJECTIVE: Given a wet-cell battery, a battery charger, and a hydrometer, charge the battery.

PERFORMANCE GUIDE:

1. Remove cell caps.
2. Check electrolyte level.
3. Add distilled water to cells which appear low.
4. Check specific gravity.
5. Charge battery at moderate rate (to eliminate excessive boiling) for 4-6 hours.
6. Check battery periodically to determine degree of charge.
7. Turn off and remove charger when battery reaches full charge. (Use caution in handling the acid: hydrogen gas is formed during charging and is explosive. Avoid flames and sparks.)
8. Replace cell caps.

LEARNING ACTIVITIES:

1. Read pages 99 to 100, Fundamentals of Machine Operation - Preventive Maintenance, Deere and Co., 1973, and complete the following:

   A. Within the battery, current flow is from _____ to the _____ terminal.
   B. To recharge the battery, the flow of current is _____, restoring the chemicals in the battery to their active state.
   C. Will a battery that is badly sulfated accept a fast charge? What will happen if you charge it too fast?
   D. Why should you remove the battery caps while charging the battery?
   E. When is a battery considered fully charged?
   F. What is the normal slow charging period?
   G. How would you know if it was time to replace the battery?

2. Observe filmstrip, Fleet Battery Care, Delco-Remy, Division of General Motors, Anderson, Indiana.

3. Read Chapter 3, Fundamentals of Service - Electrical Systems, Deere and Co., Moline, Ill., 1972.

4. In the shop area, charge a wet cell battery. Refer to the Performance Guide where necessary.

SUPPLEMENTAL READINGS:

1. Page 24, The Tractor Electrical System, AAVIM.
2. Read Section F, Unit II, Diesel Engine Mechanics, Mid-America Vocational Curriculum Consortium.

CRITERION EVALUATION: Electrolyte level should be 3/8" above plate. The hydrometer reading by the student should be exactly the same as the instructor's reading on each cell.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING STORAGE BATTERY

COMPETENCY: Clean battery terminals, cables, and battery box.

PERFORMANCE OBJECTIVE: Given a dirty battery, a box-end wrench set, clamp puller, terminal cleaning brush, sandpaper, baking soda, carrying strap, and rags, clean the battery terminals, cables, and battery box.

PERFORMANCE GUIDE:

1. Disconnect battery ground cable first, using box-end wrenches, screwdriver, and clamp puller.
2. Loosen hold-down clamps.
3. Remove battery from tractor.
4. Clean battery terminals, cables, and battery box with brushes, sandpaper, and baking soda. Flush with clean water.
5. Dry battery with clean rags.
6. Replace battery in tractor.
7. Tighten hold-down clamps.
8. Connect battery (ground cable last).

LEARNING ACTIVITIES:

1. Read pages 63-65, Tractor Maintenance, AAVIM, 1975, and complete the following:

   A. Why is it important to keep the battery clean?
   B. _____ and _____ that collects on top of a battery will cause the battery to discharge much _____.
   C. When disconnecting the battery, why should you loosen the ground strap first and connect it last?
   D. Describe the procedure you should use when cleaning a battery with baking soda.
   E. What could happen if you connect the battery cables to the wrong battery terminals?

2. Read page 96, Fundamentals of Service, Electrical Systems, Deere and Co., Moline, Ill., 1972, and complete the following:

   A. How often should you clean your tractor battery?
   B. Why should you never pound on the battery terminal?
   C. What is the purpose of putting petroleum jelly on the terminals and clamps?

3. Observe filmstrip, Fleet Battery Care, Delco-Remy, Division of General Motors, Toledo, Ohio.

4. With the help of the Performance Guide, clean the battery terminal, cables, and battery box on the designated tractor.

SUPPLEMENTAL READINGS:

1. Page 426, Mechanics in Agriculture, Lloyd J. Phipps, Second Edition, 1977, The Interstate Publishers.
2. Pages 48-50, Agricultural Machinery, Tractor Engine Tune-Up, University of West Virginia Publication, 1973.
3. Chapter 3, Fundamentals of Service - Electrical Systems, Deere and Co., Moline, Ill., 1972.

CRITERION EVALUATION: The cleaned parts should show no visible signs of dirt, moisture, or acid, and no clamps should move when pressure is applied to them.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING STORAGE BATTERIES

COMPETENCY: Measure the specific gravity using a hydrometer

PERFORMANCE OBJECTIVE: Given a battery, hydrometer and a specific gravity explanation chart, measure the specific gravity in each battery cell.

PERFORMANCE GUIDE:

1. Remove the battery caps.
2. Holding the hydrometer vertically, insert the nozzle into a battery cell.
3. Squeeze hydrometer bulb to draw electrolyte into the cylinder.
4. Adjust electrolyte level (if necessary activate the battery for several hours to mix electrolyte thoroughly).
5. With float at eye level, read scale.
6. Take the temperature of the elctrolyte. Add .004 to reading for each 10° above 800°F. and subtract .004 for each 10° below 80°.
7. Return electrolyte to cell by squeezing bulb.
8. Clean hydrometer with clear water after each cell is tested.
9. Check other cells.
10. Interpret readings using shop specific gravity chart.
11. Clean and store hydrometer.

LEARNING ACTIVITIES:

1. Read pages 7-14 of Tractor Maintenance, AAVIM, 1975, and complete the following:

   A. What is the function of the battery electrolyte?
   B. Why should the electrolyte level be above the battery plates?
   C. Why should the battery be maintained at or near full charge?
   D. What is the correct procedure in use of a hydrometer for checking the battery charge?
   E. Explain how the specific gravity is adjusted for temperatures of more or less than 80°F.

2. If you have difficulty in completing the above or as directed by the instructor, read Unit 3-8, "Testing the Battery," Fundamentals of Service - Electrical Systems, John Deere Service Publications, 1972.

3. Using the assigned battery, measure the specific gravity of each cell and interpret the hydrometer readings. You may refer to the Performance Guide whenever necessary.

SUPPLEMENTAL READINGS:

1. Servicing the battery, page 49, Agricultural Machinery Tractor Engine Tune-Up - University of W.VA. 1973. Layle D. Lawrence, Editor.
2. Diesel Engine Mechanics, William A. Foutes. Pages D-78-F - D-79-F.
3. The Tractor Electrical System, pages 20-23. AAVIM.

CRITERION EVALUATION: The measurement should be exactly the same as your instructor's measurement for each cell. No electrolyte should be spilled on or around the battery.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING STORAGE BATTERY

COMPETENCY: Measure the voltage of a battery using the voltmeter

PERFORMANCE OBJECTIVE: Given a battery and a voltmeter with regular or expanded scale divisions, measure the battery voltage.

PERFORMANCE GUIDE:

1. Connect the positive lead of the voltmeter to the positive post of the battery.
2. Connect the negative lead of the voltmeter to the negative post of the battery.
3. Disconnect the coil wire from distributor cap.
4. Turn on starter switch just long enough to get voltmeter reading.
5. Disconnect positive and negative leads from the battery; replace coil wire.
6. Interpret voltmeter reading to determine if the battery needs recharging.

LEARNING ACTIVITIES:

1. Read pages 3-10 to 3-11, Fundamentals of Service - Electrical Systems, Deere and Co., Moline, Ill., 1972.

2. Read page 426, Mechanics in Agriculture, Lloyd Phipps, Second Edition, 1977.

3. Answer the following questions.

   A. Explain how you can tell if the battery is good and sufficiently charged. Needs charging? Defective, damaged, or worn out? Too low to test accurately?
   B. Boost charge all 12-volt batteries rated 100 ampere-hours or less at ____ amps for ____ minutes.
   Charge all other batteries, both 6- and 12-volt, at ____ amps for ____ minutes.

4. Using a voltmeter, measure the voltage on the designated battery.

SUPPLEMENTAL READING: 1. Page 14, Tractor Maintenance, AAVIM, 1975.

CRITERION EVALUATION: The obtained measurement will be within one volt of the measurement obtained by the instructor.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING STORAGE BATTERY

COMPETENCY: Run a load test on a battery

PERFORMANCE OBJECTIVE: Given a hydrometer, load-test machine and voltmeter, run a load test on a battery. The voltage should not drop below 4.5 volts on a 6-volt battery nor below 9.0 on a 12-volt battery.

PERFORMANCE GUIDE:

1. Check specific gravity.
2. Connect load test machine according to manufacturer's instructions.
3. Run load test with testing machine.
4. Record results.
5. Disconnect machine.

LEARNING ACTIVITIES:

1. Read pages 11-14, Tractor Maintenance, AAVIM 1975.

2. Read pages 3-9 to 3-13, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972.

3. Observe filmstrip, Fleet Battery Care, Delco-Remy, Division of General Motors, Anderson, Ind.

4. Read Care, Maintenance, and Testing of Individual Cell Covered Batteries, Delco Remy, Division of General Motors, Anderson, Ind.

5. Complete the following questions.

   A. What conditions must exist before a "highrate-discharge test" can be performed on a battery?
   B. If the battery is in satisfactory condition, what should the terminal voltage reading be for a 6-volt battery? 12-volt battery?
   C. If you are using a voltmeter and the starter for loading the battery, how long should you apply the load?

6. Run a load test on the designated battery using a testing machine.

SUPPLEMENTAL READINGS:

1. Page 98, Fundamentals of Machine Operation - Preventive Maintenance, Deere and Co., Moline, Ill., 1973.
2. Page D-81-F, Diesel Engine Mechanics, William A. Foutes, Mid-America Vocational Curriculum Consortium, Inc., 1979.
3. Pages 425-426, Mechanics in Agriculture, Lloyd J. Phipps, Second Edition, 1977, The Interstate Printers and Publishers, Inc.

CRITERION EVALUATION: Recorded results should not vary more than .2 volt from the instructor's.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING STORAGE BATTERY

COMPETENCY: Run a load test on a battery using the starter motor

PERFORMANCE OBJECTIVE: Given a hydrometer and voltmeter, run a load test on a battery using the starting motor. The voltage should not drop below 4.5 volts on a 6-volt battery nor below below 9.0 on a 12-volt battery.

PERFORMANCE GUIDE:

1. Check specific gravity.
2. Have ignition off.
3. Remove the coil wire from the distributor and ground it to the engine.
4. Connect voltmeter to battery.
5. Engage starter for 15 seconds at a time.
6. Observe the battery voltage reading on the voltmeter.

LEARNING ACTIVITIES:

1. Read pages 11-14, Tractor Maintenance, AAVIM, 1975.

2. Read pages 3-9 to 3-11, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972.

3. Observe filmstrip, Fleet Battery Care, Delco-Remy, Division of General Motors, Anderson, Indiana.

4. Read Care, Maintenance, and Testing of Individual Cell Covered Batteries, Delco-Remy,Division of General Motors, Anderson, Indiana.

5. Complete the following questions:

   A. How would you interpret the cell voltages after you complete the load test on the battery?
   B. A difference of more than _____ specific gravity points between cells indicates an unsatisfactory battery condition.
   C. Specific gravity should read from _____ to _____.
   D. What are two key facts to remember when testing batteries?

6. Run a load test on the designated tractor battery using the starter motor.

SUPPLEMENTAL READINGS:

1. Page 98, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.
2. Page D-81-F, Diesel Engine Mechanics, William A. Foutes, Mid America Vocational Curriculum Consortium, Inc., 1977.

3. Pages 425-427, Mechanics in Agriculture, Lloyd J. Phipps, Second Edition, 1977, The Interstate Printers and Publishers, Inc.

CRITERION EVALUATION: Recorded results should not vary more than .2 volt from the instructor's.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING STORAGE BATTERY

COMPETENCY: Tighten battery cables and battery hold-down

PERFORMANCE OBJECTIVE: Given a battery with loose battery cables and battery hold-down clamps, battery pliers, and a socket wrench, tighten the cables and hold-down clamps.

PERFORMANCE GUIDE:

1. Tighten battery cables.
2. Tighten battery hold-down clamps.
3. Test for tightness by applying moderate pressure to the cables and battery.
4. Retighten loose connections.

LEARNING ACTIVITIES:

1. Read pages 10-11, Tractor Maintenance, AAVIM, 1975, and complete the following:

   A. What will happen to the battery if the hold-down clamps are loose?
   B. What could happen if you tighten the hold-down clamps to much?
   C. How can you know if you have tightened the clamps properly?
   D. What will happen if your battery has a loose terminal?

2. Read pages 3-17 to 3-19, Fundamentals of Service, Deere and Co., Moline, Ill., 1972, and complete the following:

   A. Why should you never hammer loose battery clamps in place?
   B. What is the recommended tool for tightening the hold-down clamps?

3. With the help of the performance guide, tighten the battery cables and the battery hold-down clamps on the designated tractor.

SUPPLEMENTAL READING:

1. Pages 92-102, Fundamentals of Machine Operation - Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

CRITERION EVALUATION: Upon completion of this task, neither the cables nor battery should move when pressure is applied by the instructor.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING STORAGE BATTERY

COMPETENCY: Treat battery terminals to prevent corrosion

PERFORMANCE OBJECTIVE: Given a battery, with clean terminals, and a supply of light grease, treat the battery terminals.

PERFORMANCE GUIDE:

1. Apply a thin layer of light grease, such as petroleum jelly, to the posts and cable-clamp connection. (Avoid areas where electrical contact is made.)
2. Wipe off excess grease with a clean rag.
3. Dispose of greasy rags.

LEARNING ACTIVITIES:

1. Read pages 96-98, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

2. Read pages 63-65, Tractor Maintenance, AAVIM, 1975.

3. Answer the following questions:
   A. What causes corrosion to form on the battery terminals?
   B. Why should you never put the grease on the areas between the post and clamps where electrical contact is made?
   C. How often should battery terminals be cleaned?

4. Observe filmstrip, Fleet Battery Care, Delco-Remy.

5. Watch another student as they successfully treat a battery terminal.

6. With the help of the Performance Guide, treat the battery terminals on the designated tractor to prevent corrosion.

SUPPLEMENTAL READINGS:

1. Pages 48-50, Agricultural Machinery-Tractor Engine Tune-up, West Virginia Publication, 1973.
2. Page 3-18, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972.

CRITERION EVALUATION: All areas that are subject to corrosion should be coated with light grease.

SECTION IV Maintaining and Servicing the Ignition Circuit

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11. Test Ignition Distributor 68

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING STORAGE BATTERY

COMPETENCY: Jump-start a battery with jumper cables

PERFORMANCE OBJECTIVE: Given a set of jumper cables, a tractor with a "good" battery, a tractor with a "weak" battery, and an owner's manual, start the stalled tractor with the good battery.

PERFORMANCE GUIDE:

1. Check owner's manual for complete details.
2. Remove vent caps to check fluid level before jump starting. (NOTE: If fluid is not visible or appears to be frozen, do not jump start.)
3. Replace vent caps and shield vent openings of both batteries with rags. (NOTE: Only start batteries with the same voltage (12-12 or 6-6.)
4. Hook one clamp to the "weak" battery terminal which is wired to the starter (positive (+) terminal).
5. Hook the other end of the cable with same color clamp to the positive (+) terminal of the "good" battery.
6. Hook third clamp to the negative (-) terminal on the "good" battery.
7. Hook the remaining clamp to the frame of the tractor as far away from the battery as possible. (NOTE: Make sure the clamp on the positive terminals are secure and that they are connected to the same cable.)
8. Start the tractor and remove the clamps in reverse order as soon as possible. Remove the clamp on the tractor frame first.

LEARNING ACTIVITIES:

1. Complete the following questions:

   A. Describe first aid procedures for internal and external contact with battery fluid.
   B. Why should you never smoke any where near a storage battery?
   C. What would happen if you connected the battery terminals the wrong way?

2. Draw a diagram of the correct procedure for using jumper cables.

3. Read the service manual for additional information in order to jump start a tractor.

4. With the help of the Performance Guide, jump start a tractor.

CRITERION EVALUATION: The connection of the jumper cables will meet the instructor's approval.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE IGNITION CIRCUIT

COMPETENCY: Measure resistance using ohmmeter

PERFORMANCE OBJECTIVE: Given an ignition wire, service manual, ohmmeter, and necessary tools and equipment, measure the resistance of the wire.

PERFORMANCE GUIDE:

1. Calibrate the ohmmeter.
2. Check wire specifications in service manual.
3. Attach ohmmeter leads to ignition wire.
4. Read ohmmeter scale to determine the resistance.

LEARNING ACTIVITIES:

1. Read pages 1-4 and 1-8, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972 and answer the following questions.

   A. What causes resistance?
   B. What is the basic unit of resistance?
   C. One ohm is the resistance that will allow one _____ to flow when the potential is one volt.
   D. What are three things in a copper wire that will help determine the resistance?
   E. The _____ the wire the greater the _____.
      The _____ the wire the greater the _____.
      The _____ the wire the greater the _____.

2. Calibrate the ohmmeter by following the instructions included with the ohmmeter or those given by the instructor.

3. With the help of the performance guide measure the resistance in a piece of ignition wire.

SUPPLEMENTAL READINGS:

1. Pages 5 and 6, The Tractor Electrical System, AAVIM and FIEI.

CRITERION EVALUATION: The measurement of the wire's resistance will be within ±5% of the specifications in the service manual.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE IGNITION CIRCUIT

COMPETENCY: Replace distributor points and condenser

PERFORMANCE OBJECTIVE: Given distributor points and condenser, service manual, feeler gauge, dwell meter, and ignition wrench set, replace the points and condenser on the designated tractor.

PERFORMANCE GUIDE:

1. Refer to operator's manual for specifications.
2. Remove breaker arm and spring.
3. Remove stationary breaker point bracket.
4. Clean, then lubricate cam with petroleum jelly or multi-purpose grease.
5. Replace condenser.
6. Install new points in reverse order of the procedure used in the disassembly.
7. Set breaker points using a feeler gauge, check with dwell meter.

LEARNING ACTIVITIES:

1. Read pages 6-6 to 6-8 and 6-13 to 6-15 of Fundamentals of Service-Electrical Systems, and answer the following questions.

   A. Explain the function of a condenser.
   B. What are 4 problems that can be caused by a faulty condenser?
   C. What would you use to check the condition of a condenser? What are 4 things you would check for?
   D. Name 6 things you would look for when checking the contact points assembly and describe each of them.

2. If you have difficulty in completing the above activity, or if so directed by the instructor, read pages 93-98, Tractor Maintenance, AAVIM 1975.

   A. List the steps you would use when adjusting the breaker points.
   B. Draw a sketch of properly aligned points.
   C. What will happen if you set the points too close? Too wide?

3. Read section 7, Farm Tractor Tune-Up and Service Specifications, in order to find the correct cam dwell angle for tractors with distributor-ignition systems.

4. Replace the distributor points and condensor on the designated tractor with the help of the Performance Guide.

SUPPLEMENTAL READINGS:

1. Pages 32-35, The Tractor Electrical System, AAAE and VA Publications, Athens, Ga.
2. Pages 112-115, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

3. Pages 21-24, Agricultural Machinery Tractor Tune-Up, West Virginia University Publication, 1973.

CRITERION EVALUATION: The point gap setting should be 100% accurate as specified in the operator's manual. The condenser when replaced will operate correctly.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE IGNITION CIRCUIT

COMPETENCY: Replace ignition distributor

PERFORMANCE OBJECTIVE: Given an ignition distributor, operator's manual, and necessary tools, replace the ignition distributor on the designated tractor.

PERFORMANCE OBJECTIVE:

1. Remove primary and secondary ignition wires from distributor.
2. Check and mark position of rotor.
3. Loosen mounting bolts and remove distributor.
4. Install a new distributor. Rotor must be in the same position as it was in the old distributor.
5. Reconnect primary and secondary ignition wires.
6. Set ignition timing using a timing light.
7. Set breaker points using a dwell meter.

LEARNING ACTIVITIES:

1. Read pages 89-99, Tractor Maintenance, AAVIM, 1975.

2. Read pages 6-8 to 6-16, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972.

3. Observe film strip, 20,000 Volts Under the Hood, Delco-Remy, Division of General Motors, Anderson, Ind., 46011.

4. Replace the ignition distributor on the designated tractor.

SUPPLEMENTAL READING:

1. Pages 106-117. Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

CRITERION EVALUATION: The distributor housing will have been properly marked before removal from engine. The distributor will be inspected for wear and damage and corrected before replacing in engine block. Distributor will be placed in engine without force. Locate the timing marks. Timing will be set in accordance with manufacturer's specification with 90% accuracy.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE IGNITION CIRCUIT

COMPETENCY: Replace primary ignition wire

PERFORMANCE OBJECTIVE: Given necessary tools, equipment, wire material, and operator's manual, replace the primary ignition wire on the designated tractor.

PERFORMANCE GUIDE:

1. Get information on wire size from service manual.
2. Identify end of primary wire.
3. Remove wire
4. Check wire for resistance using an ohmmeter.
5. Check wire size.
6. Prepare replacement, cut new wire to proper length, replace terminals using crimpers.
7. Check with ohmmeter for manufacturer's specifications.
8. Replace wire and connect to system.

LEARNING ACTIVITIES:

1. Read page 99, Tractor Maintenance, and complete the following.

   A. What will happen to the ignition wires which are covered or saturated with grease or oil?
   B. What should you do if you find that the insulation is broken on the ignition wire?

2. Check service manual for correct wire size.

3. Replace the primary ignition wire on the designated tractor with the help of the performance guide and operator's manual.

SUPPLEMENTAL READINGS: Pages 90-91, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

CRITERION EVALUATION: Wire size and resistance reading should be 100% accurate as indicated by manufacturer's specifications. The replaced wire should be properly connected to distributor and coil.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE IGNITION CIRCUIT

COMPETENCY: Replace secondary ignition wires

PERFORMANCE OBJECTIVE: Given necessary tools, equipment, materials, and operator's manual, replace the secondary ignition wires.

PERFORMANCE GUIDE:

1. Get information on wire size from service manual.
2. Determine rotation and firing order.
3. Remove and number spark plug wires.
4. Cut new wires to specified length or resistance as required by the manufacturer (carbon or resistance).
5. Install dust covers and terminals; crimp in place.
6. Reinstall beginning with No. 1 wire to No. 1 plug, continue in firing order until complete. (Note: Check manufacturer's specifications on which wires must not be close together.)
7. Check for proper operation.

LEARNING ACTIVITIES:

1. Find the information in your tractor's service manual regarding the correct secondary ignition wires size and type.

2. The secondary ignition wires connect the _____ with the _____.

3. What is another name for secondary ignition wires?

4. With help from the tractor's service manual and the performance guide, replace the secondary ignition wires on the designated tractor.

SUPPLEMENTAL READINGS:

1. Pages 90-91, Fundamentals of Machine Operation - Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

CRITERION EVALUATION: Wire size and resistance reading should be 100% accurate as indicated by manufacturer's specifications. The replaced wire should be properly connected to the distributor and spark plugs.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE IGNITION CIRCUIT

COMPETENCY: Service spark plugs

PERFORMANCE OBJECTIVE: Given a spark plug, an operator's manual, and the necessary tools and equipment, service the plug and set the gap.

PERFORMANCE GUIDE:

1. Check operator's manual for proper gap setting.
2. Remove spark plug wire.
3. Loosen spark plug and blow debris away from around plug with an air hose.
4. Remove spark plug from engine.
5. Visually inspect for broken or damaged parts, condition of electrode and terminal. Replace if defective.
6. Clean the spark plug using sandblasting equipment.
   NOTE: The warranty on some engines and tractors is made void by using sandblasting.
7. Adjust spark plug gap.
8. Reinstall plug. Start plug by hand, torque to manufacturer's specification of tightness.
9. Reinstall spark plug wire.

LEARNING ACTIVITIES:

1. Read pages 6-17 to 6-24, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972, and answer the following questions:

   A. Give the names of 4 different kinds of spark plugs that are unique in design and suit a special application. Tell why they are different, and describe what they each do.
   B. If you find one bad spark plug is it better to just replace the bad spark plug or should you replace all of them?
   C. What does a spark plug gasket do?
   D. Why should you never reuse the old gasket?
   E. What are the three basic steps to servicing a spark plug? Describe each of them.
   F. What are the two main failures of spark plugs? What causes these failures?

2. Read pages 54-62, Tractor Maintenance, AAVIM, 1975, and complete the following:

   A. Why should you never use an open-end or box-end wrench or a set of pliers when removing plugs from an engine?
   B. Why should you blow loose materials from plugs with compressed air?
   C. How can you determine the proper gap setting for a plug?

3. Check the owners manual or Tractor Tune-Up Service Specifications, AAVIM, for spark plug selection.

4. Clean and service a spark plug.

SUPPLEMENTAL READINGS:

1. Pages 102-106, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.
2. Pages 16-18, Agricultural Machinery Tractor Engine Tune-Up, West Virginia, Publication, 1973.
3. Page D-183-F, Diesel Engine Mechanics, William A. Fouts. Developed by the Mid-America Vocational Curriculum Consortium, Inc.

CRITERION EVALUATION: The spark plug will be serviced and the gap will be set to 100% accuracy as specified by the operator's manual.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE IGNITION CIRCUIT

COMPETENCY: Set breaker point dwell using a dwell meter

PERFORMANCE OBJECTIVE: Given a tractor with operational distributor, operator's manual, feeler gauge, dwell meter, and ignition tool set, set the breaker points.

PERFORMANCE GUIDE:

1. Refer to operator's manual for proper specifications.
2. Turn engine until cam opens breaker points to widest position.
3. Check points for proper spacing, using a feeler guage.
4. If adjustment is necessary, loosen lock screw on bracket.
5. Adjust points for proper spacing and alignment.
6. Recheck gap between points and wipe clean.
7. Check and make final adjustments using the dwell meter:
   a. Connect dwell meter lead to primary circuit.
   b. Connect dwell meter lead to ground.
   c. Start engine.
   d. Read dwell; make proper adjustments. (If external adjustment is not available, regap points internally to correct dwell.)

LEARNING ACTIVITIES:

1. Read pages 96-99, Tractor Maintenance, AAVIM 1975, and complete the following.

   A. Why should you lubricate the cam with a special high temperature grease when replacing breaker points?
   B. Describe how you would check the breaker points with a feeler gauge.
   C. Explain what an eccentric or adjusting screw does.
   D. What will happen if you set the points too close? Too wide?
   E. What will happen if the breaker-point faces do not fit together squarely?
   F. What is the purpose of running a strip of paper or clean cloth between the contact points after they have been adjusted?

2. Read pages 112-115, Fundamentals of Machine Operation - Preventive Maintenance, Deere and Co., Moline, Ill., 1973 and answer the following.

   A. You should always replace the _____ at the same time you replace the breaker points.
   B. What is the cam angle?
   C. As the cam angle increases, the point gap _____.
   D. If the cam angle reading on the dwell meter varies more than two degrees, what should you look for?
   E. Will the breaker point gap affect the ignition timing? Why?

3. Find the feeler gauge thickness recommended for your tractor. This information can be found in your operator's manual or Farm Tractor Tune-Up and Service Specifications, AAVIM.

4. Set the breaker point dwell using a dwell meter on the designated tractor.

SUPPLEMENTAL READINGS:

1. Pages 6-14, Fundamentals of Service - Electrical Systems, Deere and Co., Moline, Ill., 1972.
2. Page 34, The Tractor Electrical System, AAVIM, Engineering Center, Athens, Ga.
3. I & T Shop Manual, Technical Publications, Inc.

CRITERION EVALUATION: The breaker points will be set to 100% accuracy as specified in the operator's manual.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE IGNITION CIRCUIT

COMPETENCY: Set ignition timing using a timing light

PERFORMANCE OBJECTIVE: Given a tractor that is out of time, operator's manual, a timing light and the necessary tools, set the ignition timing.

PERFORMANCE GUIDE:

1. Check operator's manual for proper specifications.
2. Locate timing marks on flywheel or fan pulley.
3. Connect timing light as recommended by manufacturer.
4. Determine from operator's manual what timing mark to use with light, and correct engine RPM.
5. Chalk the timing mark so it is easily seen.
6. Start engine and run at speed recommended in operator's manual.
7. Direct timing light at markings on flywheel or on fan pulley.
8. Loosen clamps that hold distributor.
9. Turn distributor body slightly until timing mark is opposite the pointer.
10. Tighten distributor.
11. Recheck timing after tightening.
12. Remove timing light.
13. Replace cover over timing hole if removed.

LEARNING ACTIVITIES:

1. Read pages 6-16, Fundamentals of Service, Electrical Systems, Deere and Co., Moline, Ill., 1972 and answer the following questions.

   A. What is the reason for timing the distributor?
   B. Name and describe the two ways improper timing can effect engine performance.

2. Read pages 99-102, Tractor Maintenance, AAVIM, 1975 and answer the following questions.

   A. What are two methods of timing an engine which can be done on the farm? Which is better? Why?
   B. What does "Proper Timing" mean?
   C. Where are the timing marks located?
   D. How do you hook up a two wire type timing light? Three wire type? 110-volt type?
   E. Why should you chalk the timing mark?

3. Check the operators manual or Farm Tractor Tune-up and Service Specifications, AAVIM, to determine which timing mark indicates dead center.

4. Set the timing on the tractor.

SUPPLEMENTAL READINGS:

1. Pages 25-26, Agricultural Machinery Tractor Engine Tune-up. West Virginia University Publication, 1973.

2. Pages 116-117, Fundamentals of Machine Operation - Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

CRITERION EVALUATION: The ignition timing will be set as specified in the operator's manual with 100% accuracy when the job is complete.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE IGNITION CIRCUIT

COMPETENCY: Test distributor advance mechanism

PERFORMANCE OBJECTIVE: Given a tractor with distributor having an advance mechanism, an operator's manual, a timing light with advance adjusting mechanism, and the necessary tools and equipment, test the distributor advance mechanism.

PERFORMANCE GUIDE:

1. Check operator's manual for initial time, RPM at initial timing, RPM at mechanical advance, vacuum advance degrees, RPM at vacuum advance beginning, and high RPM total advance.
2. Connect timing light according to manufacturer's specification; disconnect and plug vacuum advance.
3. Start engine and adjust engine RPM to low idle.
4. Check initial timing with timing light, and advance the unit on the timing light; set at zero.
5. Adjust initial timing to correct specifications.
6. Bring engine to RPM of full mechanical advance, rotate timing advance mechanism in timing light until original timing marks are together; read mechanical advance on timing light dial.
7. Connect vacuum advance to distributor.
8. Bring engine RPM to high idle.
9. Rotate timing light advance dial until original marks are together.
10. Read degrees of total advance on dial and compare with manufacturer's specifications.

LEARNING ACTIVITIES:

1. Read page 109, Fundamentals of Machine Operation - Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

2. Find in the operator's manual the initial timing, RPM at initial timing, RPM at mechanical advance, vacuum advance degrees, RPM at vacuum advance beginning, and high RPM total advance.

3. With the help of the performance guide and an operator's manual, test the distributor advance mechanism on the designated tractor.

SUPPLEMENTAL READINGS:

1. Page 109, Fundamentals of Service-Electrical System, Deere and Co., Moline, Ill, 1972.

CRITERION EVALUATION: The results should be within three degrees of the specifications in the operator's manual.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE IGNITION CIRCUIT

COMPETENCY: Test and replace ignition coil

PERFORMANCE OBJECTIVE: Given an ignition coil, an oscilloscope tester, and the necessary tools and equipment, test and replace the coil on the designated tractor.

PERFORMANCE GUIDE:

1. Remove wires from coil.
2. Connect suitable coil tester to input and output on coil.
3. Select correct voltage on tester.
4. Rotate calibration knob on lowest level of power input.
5. Adjust pattern length on the oscilloscope until one full wave length is desplayed.
6. Rotate calibration knob until a reading of 20 KV is reached; if 20 KV reading is reached with full display pattern, the coil is serviceable.
7. If 20 KV reading is not reached, check for reasons such as the coil being shorted open or reverse polarity.
8. If reverse polarity is noted, switch leads between plus (+) and minus (-) outlets on coil and recheck.
9. If shorted-open problems are noted, replacement of coil is necessary.
10. Obtain the correct coil for the tractor and replace the coil using a screwdriver.
11. Recheck to get correct reading.

LEARNING ACTIVITIES:

1. Read pages 6-3 to 6-6, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972, and complete the following questions:

   A. What is an ignition coil and what is its function?
   B. What are some symptoms of a faulty coil?
   C. What are two methods of checking the ignition coil voltage strength?
   D. Can a coil be repaired if it has a crack in it? Why?

2. Read IC-100, Separetely Mounted Coils, Delco-Remy, Division of General Motors, Anderson, Ind.

3. Test and replace the ignition coil on the designated tractor.

SUPPLEMENTAL READING: 1. Pages 19-20, Agricultural Machinery, Tractor Tune-Up, West Virginia University Publication, 1973.

CRITERION EVALUATION: Student reading on test indicator will be identical to instructor's reading.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE IGNITION CIRCUIT

COMPETENCY: Test ignition distributor

PERFORMANCE OBJECTIVE: Given a tractor with an ignition distributor and the necessary tools and equipment, check the condition of the distributor.

PERFORMANCE GUIDE:

1. Remove dirt from outside surface of distributor and cap.
2. Remove cap and clean inner surfaces; leave wires connected.
3. Check distributor cap for chips, breaks, or cracks. Replace if defective.
4. Remove and clean distributor arm (rotor).
5. Remove dust cover, if one is used, and check condition of felt seal.

LEARNING ACTIVITIES:

1. Read pages 93-96, Tractor Maintenance, AAVIM 1975, and complete the following:

   A. Why is it important to keep the distributor cap clean and dry?
   B. Moisture plus ozone will form _____ that corrodes the metal parts of the distributor.
   C. If the distributor is cracked, shows excessive wear, or chips what should you do?
   D. What will happen if the felt seal is worn and not replaced?

2. Read page 111, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

   A. What causes carbon paths?
   B. What will happen once one of these paths is formed?

3. Check the condition of the distributor on the designated tractor.

SUPPLEMENTAL READINGS: Pages 6-12 to 6-13, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972.

CRITERION EVALUATION: Evaluation will be based on successful completion of all the steps in the performance guide.

SECTION V Maintaining and Servicing the Cooling System

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2. Replace Radiator Hose 71

3. Replace Water Pump 72

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5. Test Cooling System for Leaks 74

6. Test Radiator Coolant 75

7. Test Radiator Pressure Caps 76

8. Replace Cooling System Thermostat 77

9. Test Thermostat 78

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE COOLING SYSTEM

COMPETENCY: Flush and clean radiator

PERFORMANCE OBJECTIVE: Given a water hose, appropriate tools, and a designated tractor, flush and clean the radiator system.

PERFORMANCE GUIDE:

1. Put on protective goggles.
2. Remove radiator cap.
3. Disconnect radiator hose with screwdriver and hose-clamp pliers.
4. Remove thermostat.
5. Replace thermostat elbow.
6. Run water through the cooling system until it runs clean. (Note: Flushing compound and back-flushing may be needed for extremely dirty systems.)
7. Reinstall thermostat and radiator hose.
8. Clean foreign materials from outside of radiator.
9. Refill cooling system and check for leaks.

LEARNING ACTIVITIES:

1. Read pages 125-128, Tractor Maintenance, AAVIM, and complete the following questions:

   A. Why should the engine be warmed up before you drain the radiator?
   B. Why should you add the water slowly when refilling the radiator?
   C. List the 7 steps you would use to flush a tractor's cooling system.

2. Check Farm Tractor Tune-Up and Service Specifications for the correct coolant requirements for your tractor.

3. If you are directed by the instructor, or need further information, read the following and answer the questions, pages 8-10 to 8-12, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

   A. When is the best time to check the cooling liquid?
   B. How would you go about rust-proofing your tractor's cooling system?
   C. When would you use a cooling system cleaner? What are they effective on?

4. Using the proper tools, a water hose, flush and clean the radiator system on an assigned tractor. Use the Performance Guide as needed.

SUPPLEMENTAL READINGS:

1. Pages 10 and 11, Tractor Operation and Daily Care, AAVIM, 1976
2. Pages 81 and 82, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

CRITERION EVALUATION: The cleaned cooling system should show no evidence of containing dirty coolant or foreign materials. There will be no spilled coolant left on or around the tractor when the job is complete.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE COOLING SYSTEM

COMPETENCY: Replace radiator hose

PERFORMANCE OBJECTIVE: Given a screwdriver, hose-clamp pliers, and scraper, replace the radiator hose on the designated tractor.

PERFORMANCE GUIDE:

1. Drain cooling system.
2. Remove old hose.
3. Clean radiator neck and engine inlet/outlet fixtures.
4. Install new radiator hose.
5. Refill with coolant and check for leaks.
6. Tighten any loose connections.

LEARNING ACTIVITIES:

1. Read pages 8-8 to 8-9, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., and complete the following questions:

   A. How often should you replace cooling system hoses?
   B. Radiator hoses can be damaged by _____, _____, and _____.
   C. What will happen to a hose that is improperly installed?

2. Read pages 119-128, Tractor Maintenance, AAVIM 1975.

3. With the help of the Performance Guide replace the radiator hose on the assigned tractor.

SUPPLEMENTAL READING:

1. Pages 421-423, Mechanics in Agriculture, Phipps, Second Edition, 1977.

CRITERION EVALUATION: The new hose should show no visible signs of leaks.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE COOLING SYSTEM

COMPETENCY: Replace water pump

PERFORMANCE OBJECTIVE: Given a tractor with a defective water pump, access to socket set, open-end and box-end wrench set, screwdrivers, clamp pliers, and gasket sealing compound, replace the water pump.

PERFORMANCE GUIDE:

1. Drain cooling system.
2. Remove necessary equipment to reach water pump as specified by type of equipment.
3. Disconnect hoses from water pump.
4. Remove water pump from engine.
5. Clean area where new pump is to be located.
6. Coat gasket with sealing compound.
7. Install gasket on engine.
8. Install pump on gasket.
9. Reconnect hoses.
10. Replace other equipment and adjust drive belts.
11. Fill with coolant and check for leakage.

LEARNING ACTIVITIES:

1. Read pages 8-5 to 8-6, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972, and complete the following:

   A. What will happen if the water pump fails to operate?
   B. Name 3 items that basically make up a water pump.
   C. What would you inspect a faulty water pump for?

2. Find the correct I & T Shop Manual for your tractor and list the procedure you would use to replace the water pump.

3. Use the Performance Guide to help you replace the water pump on your tractor.

SUPPLEMENTAL READINGS:

1. Page 73, Fundamentals of Machine Operation - Preventive Maintenance, Deere and Co., Moline, Ill., 1973.
2. Page D-61-D, Diesel Engine Mechanics, William A. Foutes.

CRITERION EVALUATION: The replaced water pump should show no signs of leakage and all steps in the installation process should be acceptable to the instructor. The fanbelt will be adjusted to manufacturer's specifications.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE COOLING SYSTEM

COMPETENCY: Service Fanbelts

PERFORMANCE OBJECTIVE: Given a new fanbelt, service manual, open-end wrenches, and belt-tension gauge, replace the fanbelt on the designated tractor.

PERFORMANCE GUIDE:

1. Loosen tension on fanbelt.
2. Remove old belt.
3. Install new fanbelt.
4. Check for correct alignment.
5. Adjust tension to manufacturer's specifications.

LEARNING ACTIVITIES:

1. Read pages 15-17, Tractor Maintenance, AAVIM, 1975, and answer the following questions:

   A. What will happen if you tighten a fanbelt too much?
   B. What will happen if the belt is too loose?
   C. Why should the belts be dept clean?
   D. When should you replace a belt?
   E. Describe how to check the tension in the fanbelt.
   F. List and describe 5 steps you would use to adjust the tension in a fanbelt.
   G. Check with instructor before going to next step.

2. Replace the fanbelt on the designated tractor with the help of the Perfromance Guide.

SUPPLEMENTAL READINGS:

1. Page 82, Fundamentals of Machine Operation - Preventive Maintenance, Deere and Co., Moline, Ill, 1973.
2. Page 8-5, Fundamentals of Service-Engines, Deere and Co., Moline, Ill, 1972.

CRITERION EVALUATION: The tension in the new fanbelt will be adjusted to manufacturer's specifications.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE COOLING SYSTEM

COMPETENCY: Test cooling system for leaks

PERFORMANCE OBJECTIVE: Using the designated tractor and a pressure tester, test the cooling system for leaks.

PERFORMANCE GUIDE:

1. Install pressure tester on filler neck.
2. Apply pressure to maximum operating pressure.
3. Inspect for visible leaks.
4. Operate engine and observe pressure gauge. (Fluctuations indicate head gasket leakage.)
5. Remove pressure tester and replace radiator cap.

LEARNING ACTIVITIES:

1. Read page 83, Fundamentals of Machine Operation - Preventive Maintenance, Deere and Co., 1973, and complete the following questions:

   A. Before the cooling system can operate properly the components must be _____ and in _____ condition before the system can operate properly.
   B. What will happen if the pressure in the cooling system is not maintained?
   C. Before the tester is installed, make a list of what you would inspect for leakage.

2. Read pages 8-2 to 8-4, Fundamentals of Service - Engines, Deere and Co., Moline, Ill., 1972.

3. Test the cooling system on the designated tractor for leaks.

SUPPLEMENTAL READINGS: Pages 8-11, Tractor Operation and Daily Care, AAVIM, 1970.
Page 126, Tractor Maintenance, AAVIM, 1975.

CRITERION EVALUATION: All cooling system leaks should be identified.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE COOLING SYSTEM

COMPETENCY: Test radiator coolant

PERFORMANCE OBJECTIVE: Using the designated tractor and a hydrometer, test the radiator coolant supply.

PERFORMANCE GUIDE:

1. Remove radiator cap.
2. Insert hydrometer and draw enough coolant into hydrometer to get a reading. (Be sure float is not sticking.)
3. Take reading and make correction for temperature variation.
4. Replace coolant in radiator.
5. Record hydrometer reading.
6. Flush hydrometer with clear water.

LEARNING ACTIVITIES:

1. Read page 79, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

2. Test the radiator coolant in the designated tractor.

SUPPLEMENTAL READING: 1. Pages 119-128, Tractor Maintenance, AAVIM 1975.

CRITERION EVALUATION: The reading should be within one gradation of the instructor's reading on the hydrometer scale.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE COOLING SYSTEM

COMPETENCY: Test radiator pressure caps

PERFORMANCE OBJECTIVE: Using the designated tractor, a pressure tester, and an adapter, test the radiator cap for pressure tolerance.

PERFORMANCE GUIDE:

1. Install cap on pressure tester.
2. Pump up pressure tester until cap releases.
3. Record reading on the pressure tester.
4. Compare the reading on the pressure tester with cap specifications.

LEARNING ACTIVITIES:

1. Read page 8-4, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Read page 83, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

3. Complete the following questions:

   A. What does a radiator cap do?
   B. What are its two functions?
   C. Can a defective radiator cap be repaired?

4. Test the radiator cap on the designated tractor for correct pressure tolerance.

SUPPLEMENTAL READINGS:

1. Pages D-43 to D-44, Diesel Engine Mechanics, William A. Foutes, Mid-American Vocational Curriculum Consortium, Inc., 1977.
2. Pages 121-122, Tractor Maintenance, AAVIM 1975.
3. Pages 10-11, Tractor Operation and Daily Care, AAVIM 1971.

CRITERION EVALUATION: The gauge reading should be within one gradation of the instructor's reading.

STUDENT COMPETENCT SHEET

UNIT: MAINTAINING AND SERVICING THE COOLING SYSTEM

COMPETENCY: Replace the cooling system thermostat

PERFORMANCE OBJECTIVE: Given a new thermostat and gasket, a service manual, and the necessary tools, replace the cooling system thermostat on an engine.

PERFORMANCE GUIDE:

1. Clean area thoroughly.
2. Following the directions given in the manufacturer's service manual, remove old thermostat.
3. Clean gasket surfaces and install a new gasket.
4. Install new thermostat in engine water jacket. Position thermostat with expansion element toward the engine.
5. With outlet casting and gasket properly located, tighten the retaining nuts evenly and securely.
6. Start engine and check for leaks.

LEARNING ACTIVITIES:

1. Read pages 8-7 to 8-8 of Fundamentals of Service Engines, Deere and Co., Moline, Ill., 1972, and complete the following questions:

   A. Identify the common types of thermostats found in most engines.
   B. Explain what the function of a thermostat is, and what happens if it is not functioning properly.
   C. Before replacing the thermostat, what should it be inspected for?
   D. How can one decide if the thermostat is being installed right side up?

2. Read pages 8 and 9 of Tractor Operation and Daily Care, AAVIM, 1970.

3. Describe steps that you would use in replacing a thermostat.

4. Obtain the correct thermostat and gasket, a service manual and necessary tools, and practice replacing the thermostat on the engine.

SUPPLEMENTAL READING: Pages 203-204 & 206-207 Diesel Fundamentals, Service and Repair, by William K. Toboldt. Goodheart-Wilcox Company, Inc., Publisher.

CRITERION EVALUATION: The new thermostat must be clean, installed according to directions in the service manual, and function properly. There should be no coolant leaks when finished.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE COOLING SYSTEM

COMPETENCY: Test thermostat

PERFORMANCE OBJECTIVE: Using a thermometer, a container of antifreeze solution, a .003" feeler gauge, and the proper tools, test the thermostat on the designated tractor.

PERFORMANCE GUIDE:

1. Remove thermostat.
2. Fill a clear pyrex container with antifreeze solution.
3. Insert a thermometer in the solution in such a manner that it does not touch the sides or bottom of the container.
4. Insert a .003" feeler gauge between the valve and seat of thermostat.
5. Suspend thermostat in the solution so that it does not touch the sides or bottom of the container.
6. Heat solution. Stir to distribute heat evenly.
7. Note temperature when feeler gauge slips free of the valve. Compare with manufacturer's specifications.
8. Dry thermostat.
9. Reinstall thermostat.

LEARNING ACTIVITIES:

1. Read page 8-8, Fundamentals of Service - Engines, Deere and Co., Moline, Ill., 1972 and complete the following.

   A. If you discover that the thermostat is broken or corroded what should you do? Should you replace the thermostat if you find that it is not of the proper temperature and type? Why?
   B. Can you use a bellows thermostat in a high-pressure cooling system? Why?
   C. Can you use a high-temperature thermostat with an alcohol-base antifreeze?
   D. When testing a thermostat, at what temperature should the thermostat be fully open?
   E. What should you do if the thermostat does not open at this degree of temperature?

2. Read page 83, Fundamentals of Machine Operation - Preventive Maintenance, Deere and Co., Moline, Ill., 1973 and complete the following.

   A. Why is a thermostat important?
   B. Should you ever operate the tractor without a thermostat? Why?
   C. Describe how you would examine a thermostat in order to tell if it was good or bad when testing it.

3. Test the thermostat on the designated tractor.

SUPPLEMENTAL READINGS: 1. Page D-65-D, Diesel Engine Mechanics, William A. Foutes, 1977. Developed by the Mid-America Vocational Curriculum Consortium, Inc., 1977.

CRITERION EVALUATION: The thermometer reading, when the valve opens, should agree with the instructor's reading within plus or minus $\pm$ 3°F.

SECTION VI Maintaining and Servicing the Charging Circuit

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2. Adjust Voltage Regulator Using Variable Resistance Method 82

3. Check Armature and Fields 84

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5. Test a Tractor Generator on a Bench Using the Test for the Common A Circuit Generator 86

6. Replace Amperage Gauge 87

7. Replace Bearings (Alternator or Generator) 88

8. Replace Diodes 89

9. Replace Generator Brushes 90

10. Replace Heat Sink 92

11. Service the Alternator Regulator 93

12. Test Alternator Diodes 94

13. Test Charging Circuit Using a Voltmeter, Ammeter, and/or Carbon Pile 95

14. Turn Armature 96

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE CHARGING UNIT

COMPETENCY: Adjust voltage regulator using the fixed resistance method

PERFORMANCE OBJECTIVE: Given necessary tools, voltage regulator, one-fourth ohm fixed resistor, voltmeter, and technical service manual, adjust the voltage regulator using the fixed resistance method.

PERFORMANCE GUIDE:

1. Consult technical manual for pertinent specifications and procedure.
2. Insert one-fourth ohm fixed resistor into charging circuit at battery terminal.
3. Connect a voltmeter from battery terminal to ground.
4. Cycle generator by one of two methods:
   a. Slow it down until voltage drops to about one-fourth of rated value. Increase speed and note reading.
   b. Cycle generator by inserting variable resistance into field circuit. Slowly increase resistance until voltage drops to about one-fourth of rated value. Decrease resistance and note voltage reading.
5. Adjust voltage setting by turning adjusting screw. (If the adjusting screw is turned to its limit, it may be necessary to bend the spring support. Do this very carefully.) Final adjustment should always be made by increasing the spring tension. If the setting is too high, adjust the unit below the specified value and then bring it back to this value by increasing the spring tension. After each adjustment and before taking a reading, replace the cover and cycle the generator.

LEARNING ACTIVITIES:

1. Read pages 4-21 to 4-27, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972, and complete the following questions:

   A. What is the voltage regulator's main function?
   B. What are the two main types of voltage regulators?
   C. Once the problem has been traced to the voltage regulator, what are 9 preliminary test steps to be performed before adjusting the voltage regulator?
   D. Draw a diagram showing how to test a voltage regulator using the fixed resistance method.

2. Consult the I&T Shop Manual, for needed specifications and procedures.

3. Using the fixed resistance method, adjust the voltage regulator on the designated tractor.

CRITERION EVALUATION: Adjustments will meet specifications in the service manual.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE CHARGING CIRCUIT

COMPETENCY: Adjust voltage regulator
(using the variable-resistance method)

PERFORMANCE OBJECTIVE: Given necessary tools, voltage regulator, voltmeter, and technical service manual, adjust the voltage regulator using the variable-resistance method.

PERFORMANCE GUIDE:

1. Connect variable resistor and ammeter into charging circuit at battery terminal.
2. Connect voltmeter from battery terminal to ground.
3. Start generator and adjust resistor to get a current flow of not more than 10 ampers. Operate generator at specified speed to warm it up.
4. Cycle generator by one of two methods:
   a. Slow it down until voltage drops to about one-fourth of rated value. Increase speed and note reading.
   b. Insert variable resistance into field circuit. Slowly increase resistance until voltage drops to about one-fourth of rated value. Decrease resistance and note voltage reading.
5. Adjust voltage setting by turning adjusting screw. (If adjusting screw is turned to its limit, it may be necessary to bend the spring support. Do this very carefully.) Final adjustment should always be made by increasing the spring tension. If the setting is too high, adjust the unit below the specified value and then bring it back to this value by increasing the spring tension. After each adjustment and before taking a reading, replace the cover and cycle the generator.

LEARNING ACTIVITIES:

1. Read pages 4-21 to 4-28, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972, and complete the following questions:

   A. What is the main function of a voltage regulator?
   B. What are the two main types of voltage regulators?
   C. Once the problem has been traced to the voltage regulator, what are the 9 preliminary test steps that should be performed before adjusting the voltage regulator?
   D. Draw a diagram showing a voltage regulator using the variable resistance method.

2. Consult the I&T Shop Manual for any needed specifications and procedures.

3. Using the variable-resistance method, adjust the voltage regulator on the designated tractor.

CRITERION EVALUATION: Adjustments will meet specifications in the technical service manual.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE CHARGING CIRCUIT

COMPETENCY: Check armature and fields

PERFORMANCE OBJECTIVE: Given proper test lamp, growler, combination test unit, and the necessary tools and equipment, check the armature and field.

PERFORMANCE GUIDE:

1. Visually inspect armature for open circuit. (The training edge of the bar attached to the open loop will usually be badly burned.)
2. Test for open circuit using combination test unit and growler.
   a. Place test prods of unit on two adjacent commutator bars. Rotate armature to get highest meter reading. Record reading.
   b. Turn armature slightly and check two other bars. If one reading is lower than others, that circuit is open.
3. Perform additional tests for shorted armature and grounded armature if needed.
4. Test for open field circuit by using test lamp. Touch prods of lamp to generator terminals. If lamp does not light, field circuit is open.
5. Test for grounded field circuit or shorted field circuit.

LEARNING ACTIVITIES:

1. Read pages 4-14 to 4-17, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972, and complete the following questions:

   A. What are four possible failures of the armature?
   B. Describe how you would test for a shorted armature and grounded armature.
   C. (True-False) Normally the armature is replaced with another armature when it is found to be defective.

2. Observe filmstrip, Delcatron Generator and the Charging Circuit, Delco-Remy Division of General Motors, Anderson, Ind.

3. Check the armature and field in the generator in the designated tractor.

CRITERION EVALUATION: The readings on the test equipment will be the same as those obtained by the instructor.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE CHARGING CIRCUIT

COMPETENCY: Polarize a tractor generator

PERFORMANCE OBJECTIVE: Using ignition tools, polarize the generator on the designated tractor.

PERFORMANCE GUIDE:

1. Polarize the generator on externally grounded generators by touching a short insulated jumper wire momentarily between the two posts on the regulator marked "Bat" and "Gen" (sometimes marked "Arm").
2. Polarize the generator on internally grounded generator by momentarily touching the ends of the "Bat" wire and the "FLD" wire together.

LEARNING ACTIVITIES:

1. Read page 123, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill.

2. Read page 8-3, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972.

3. Complete the following questions:

   A. Draw a diagram of how you would polarize an externally grounded generator. Do the same for an internally grounded generator.
   B. Why should you always polarize the generator?
   C. Why should you never attempt to polarize an alternator system?

4. Polarize the generator on the designated tractor.

SUPPLEMENTAL READING:

1. Pages 107-108, Tractor Maintenance, AAVIM 1975).
2. Page D-230-F, Diesel Engine Mechanics, William A. Foutes, Mid-America Vocational Curriculum Consortium, Inc.

CRITERION EVALUATION: The student will be able to distinguish between an externally and internally grounded generator, to successfully polarize each of them correctly, and will demonstrate his ability to the instructor.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE CHARGING CIRCUIT

COMPETENCY: Test a tractor generator on a bench using the test for the common "A" circuit generator.

PERFORMANCE OBJECTIVE: Given an ammeter, carbon-pile resistor, voltmeter, switch and necessary tools, test the generator on the bench to determine output.

PERFORMANCE GUIDE:

1. Consult the manufacturer's technical service manual for service and repair specifications.
2. Connect an ammeter and switch in series with a battery to the generator output terminal.
3. Connect a voltmeter from the generator output to ground.
4. Connect a carbon pile resistor across the battery.
5. Connect a jumper lead to the generator field terminal.
6. Operate the generator to obtain battery voltage and close the switch.
7. Speed up the generator to its rated value, adjust the carbon pile to obtain the specified voltage and compare the current output with the generator specifications.
8. If the generator output is below par, check for additional malfunctions.

LEARNING ACTIVITIES:

1. Read pages 4-12 to 4-13, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972, and complete the following questions:

   A. List and describe four basic electrical failures that can cause a generator to malfunction.
   B. Draw a diagram of how you would test a common "A" circuit generator using a carbon-pile resistor, ammeter, voltmeter, and switch.

2. Consult the I & T Shop Manual for up-to-date lists of all generator specifications plus servicing and repair procedures.

3. Read page 123, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

CRITERION EVALUATION: The voltmeter and ammeter readings will be the same as those of the instructor.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE CHARGING CIRCUIT

COMPETENCY: Replace amperage gauge

PERFORMANCE OBJECTIVE: Given replacement amperage gauge, necessary tools and equipment, replace an amperage gauge on the designated tractor.

PERFORMANCE GUIDE:

1. Secure replacement amperage gauge.
2. Remove amperage gauge from mounting.
3. Identify source of wires connecting to amperage gauge.
4. Remove wires from old gauge and attach to new amperage gauge.
5. Mount replacement amperage gauge.

LEARNING ACTIVITIES:

1. Read pages 6-17, Tractor Electrical Systems, AAVIM and complete the following questions:

   A. What is the purpose of an ammeter?
   B. Does every tractor have an ammeter?

2. Read the sections on gauges, in the I & T Shop Manual or manufacturer's service manual.

3. With the help of the performance guide, replace the amperage gauge on the designated tractor.

CRITERION EVALUATION: The replacement gauge will function properly. The following steps will be completed and approved by the instructor.

1. Serviced correct amperage gauge.
2. Removed amperage gauge.
3. Removed wires.
4. Installed new wires.
5. Mounted amperage gauge.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE CHARGING CIRCUIT

COMPETENCY: Replace bearings (alternator or generator)

PERFORMANCE OBJECTIVE: Given a new set of bearings, a service manual, a mechanic's tool set, and an arbor press, replace the bearings in an alternator or generator.

PERFORMANCE GUIDE:

1. Identify defective bearing based on side play in armature.
2. Disassemble alternator or generator following instructions in manufacturer's service manual.
3. Press defective bearing from housing.
4. Press new bearing into housing.
5. Reassemble alternator or generator.

LEARNING ACTIVITIES:

1. Read the section on replacing bearings in either the manufacturer's service manual or I&T Shop Manual.

2. Replace the bearings in the designated alternator or generator. Use the Performance Guide whenever needed.

CRITERION EVALUATION: When service is complete the armature will run free with no side play.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE CHARGING CIRCUIT

COMPETENCY: Replace diodes

PERFORMANCE OBJECTIVE: Given an appropriate press, an alternator, soldering iron, pliers, and necessary tools, replace a diode.

PERFORMANCE GUIDE:

1. Locate defective diode.
2. Unsolder diode leads, using low heat and protecting diode from heat.
3. Press old diode out of plate.
4. Press new diode into position.
5. Solder leads.
6. Check diode for proper function.

LEARNING ACTIVITIES:

1. Read pages 1-11 to 1-13, 4-45 to 4-48, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972.

2. View the slide-tape presentation, "Servicing the Alternator."

3. Read section on alternators in the I&T Shop Manual or manufacturer's service manual.

4. Replace a diode on the designated alternator.

SUPPLEMENTAL READING:

1. Pages 51-56, The Tractor Electrical System, AAVIM, Athens, Ga.

CRITERION EVALUATION: The replacement process will include the successful completion of the following steps:

1. Located defective diode.
2. Unsoldered diode leads.
3. Pressed out old diodes.
4. Installed new diodes.
5. Soldered leads
6. Checked diode for proper function.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE CHARGING CIRCUIT

COMPETENCY: Replace generator brushes

PERFORMANCE OBJECTIVE: Given new brushes, necessary tools and equipment, replace the brushes on the designated generator.

PERFORMANCE GUIDE:

1. Check operator's manual for specifications.
2. Wipe dirt from generator housing.
3. Remove cover band.
4. Disconnect brush wire lead where it connects to brush holder
5. Lift brush tension clip.
6. Remove old brushes.
7. Clean commutator with sandpaper; wipe to clean thoroughly.
8. Slip new brushes into place.
9. Reconnect brush wire lead.
10. Replace cover band.
11. Polarize generator.

LEARNING ACTIVITIES:

1. Read page 4-18, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972, and complete the following:

   A. When should you replace generator brushes?
   B. How much of a contact area is necessary for a good seat? What will happen if the brushes are not seated properly?
   C. Use _____ _____ or _____ to get a perfect fit between the brushes and the generator.

2. Read pages 104-108, Tractor Maintenance, AAVIM, 1975, for further information on servicing the generator brushes.

3. Explain what it means to "polarize the generator". When do you need to do it?

4. Consult the I&T Shop Manual for further information on your tractor's generator.

SUPPLEMENTAL READINGS:

1. Pages 122 and 123, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., 1973.
2. Mechanics in Agriculture, Lloyd J. Phipps, Interstate Publishers, 1977.

CRITERION EVALUATION: The replacement process will include the successful completion of all the following steps:

1. cleaned generator housing
2. removed cover band
3. removed brush tension clip
4. installed new brushes
5. polarized generator

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE CHARGING CIRCUIT

COMPETENCY: Replace heat sink

PERFORMANCE OBJECTIVE: Given a charging system with a faulty heat sink, a new heat sink, service manual, the needed wrenches, alternator and soldering iron, replace the heat sink.

PERFORMANCE GUIDE:

1. Remove all parts necessary to reach heat sink by following instructions in the manufacturer's service manual.
2. Unsolder leads from diodes to stator winding.
3. Unbolt heat sink assembly.
4. Bolt new assembly in place.
5. Solder leads from diode to stator winding.
6. Reassemble all parts removed.

LEARNING ACTIVITIES:

1. Read the section on alternators in the I&T Shop Manual or manufacturer's service manual.

2. View slide-tape presentation, "Servicing the Alternator, " Competency Based Vocational Education, Maynard Iverson and James Maddox.

3. Replace the heat sink on the designated alternator using the Performance Guide and the I&T Shop Manual, where needed.

CRITERION EVALUATION: The heat sink will be in the correct position for the alternator being serviced. The diodes will function correctly when put through an alternator diode test.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE CHARGING CIRCUIT

COMPETENCY: Service the alternator regulator

PERFORMANCE OBJECTIVE: Given necessary tools, equipment, and service manual, test the alternator regulator.

PERFORMANCE GUIDE: NOTE: Most transistorized regulators have no means of repair; faulty transistorized regulators should be replaced.

1. Refer to service manual for specific instructions on operation of test equipment and alternator regulator.
2. Turn adjusting screw to desired output.
3. Test charging circuit using voltmeter, ammeter, and low carbon pile.

LEARNING ACTIVITIES:

1. Read pages 4-44 to 4-45, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972.

2. Complete the following questions:

   A. List five precautions for alternator testing.
   B. What may happen if you fail to take the above precautions?

3. Read the section on alternators in either the manufacturer's service manual or I&T Shop Manual for further information and specific instructions for servicing the alternator regulator.

4. Service the alternator regulator on the designated tractor.

SUPPLEMENTAL READINGS:
1. Pages 117-123, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.
2. Pages D-257F to D-294F, Diesel Engine Mechanics, William A. Foutes, Mid-America Vocational Curriculum Consortium, Inc., 1977.

CRITERION EVALUATION: The results of service and adjustments will be exactly as specified in the service manual.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE CHARGING CIRCUIT

COMPETENCY: Test alternator diodes

PERFORMANCE OBJECTIVE: Given a 1-½ ohm ohmmeter, and the necessary tools and equipment, test the alternator diode.

PERFORMANCE GUIDE:

1. Connect one ohmmeter lead to diode case and other ohmmeter lead to diode lead.
2. Note ohmmeter reading.
3. Reverse ohmmeter leads and note reading. A good diode will give a high and low reading. If only a slight difference in reading is noted between one diode lead to the other diode lead, the diode is probably defective.

LEARNING ACTIVITIES:

1. Read pages 4-47 to 4-48, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972 and complete the following questions:

   A. What are the two major steps you need to follow in order to test the alternator diodes?
   B. What is the first indication of a faulty diode?
   C. What color are positive diodes?
   D. What color are negative diodes?

2. Consult the I&T Shop Manual for further information on testing alternator diodes.

3. Practice testing the alternator diode. Follow the directions in the performance guide and manufacturer's service manual.

CRITERION EVALUATION: The reading on the ohmmeter will be the same as the reading obtained by the instructor.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE CHARGING CIRCUIT

COMPETENCY: Test charging circuit using a voltmeter, ammeter, and/or carbon pile.

PERFORMANCE OBJECTIVE: Given a voltmeter, ammeter, carbon-pile resistor, and necessary tools, test the charging circuit.

PERFORMANCE GUIDE:

1. Refer to machine technical manual for specific instructions and procedures.
2. Set up test circuit.
3. Connect voltmeter to alternator ground and output terminal. Voltmeter should be accurate within 0.1 volts.
4. Start engine and insert load of approximately 10 amp. (Use lights, motors, carbon pile resistors, etc.)
5. Operate circuit for 15 minutes to stabilize temperature of regulators. Measure and record temperature one inch from regulator case.
6. Compare voltmeter reading with voltage specifications listed in machine technical manual. Adjust reading for temperature recorded in Step 5.

LEARNING ACTIVITIES:

1. Draw and label the wiring diagram you will be following when testing the charging circuit.

2. Read pages 35-56, The Tractor Electrical System, AAVIM, Engineering Center, Athens, Ga.

3. Observe filmstrip, Delcotron Generator and the Charging Circuit, Delco-Remy Division of General Motors, Anderson, Ind.

4. Practice testing the charging circuit on the designated tractor with the help of the manufacturer's service manual and the performance guide.

SUPPLEMENTAL READING: I&T Shop Manual, Technical Publications, Inc.

CRITERION EVALUATION: The readings on the test equipment will be the same as those of the instructor.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE CHARGING CIRCUIT

COMPETENCY: Turn an armature

PERFORMANCE OBJECTIVE: Given an armature-turning tool, micrometer, and other necessary tools, turn an armature.

PERFORMANCE GUIDE:

1. Fasten armature in the tool for turning down an armature.
2. Turn armature until smooth and round.
3. Check for roundness with micrometer.
4. Test armature for grounds, shorts, and balance.

LEARNING ACTIVITIES:

1. Read pages 4-5, 4-14 to 4-15, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972.

2. Read pages 24-24, Fundamentals of Service-Shop Tools.

3. Check your knowledge of reading micrometers by taking the Self Test "Reading a Micrometer," to be supplied by your instructor.

4. With the help of the performance guide, turn the armature on the designated generator.

CRITERION EVALUATION: The micrometer reading will be equal to the reading obtained by the instructor.

SECTION VII Maintaining and Servicing the Starting Circuit

1. Check Armature and Fields 97

2. Check Ignition Switch 99

3. Check Safety Switches 100

4. Check Solenoid 101

5. Replace Bearings and Bushings 102

6. Replace Ring Gear 103

7. Replace Starter Brushes 104

8. Replace Starter Drive 105

9. Replace Starter Motor Solenoid 107

10. Replace Starter Motors 109

11. Turn Armature 110

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE STARTING CIRCUIT

COMPETENCY: Check armature and fields

PERFORMANCE OBJECTIVE: Using a mechanic's tool set, an armature tester (growler), a continuity-tester voltmeter, ammeter and tachometer (speed indicator), check the armature and fields of the starter on the designated tractor.

PERFORMANCE GUIDE:

1. Test the armature for grounds, shorts, and balance using the manufacturer's manual, if available, for test equipment procedures. Otherwise, use the following procedure:
   a. Ground test: Put armature in growler jaws and turn on power switch to test position. Touch one test lead to the armature core and touch the other lead to each commutator bar one at a time. Observe the test light. If the test lamp glows on any bar, the armature is grounded and has to be replaced.
   b. Short test: Put armature in growler jaws and turn power switch to growler position. Hold a steel blade parallel with, and touching, the armature core. Rotate the armature slowly one or more revolutions in the growler jaw. If the steel blade vibrates on any position of the core, then the area is shorted and the armature must be replaced.
   c. Balance test: Put armature in growler jaws and turn power switch to growler position. Put contact fingers of meter test cable across adjacent commutator bars at side of the commutator and adjust voltage control until the needle is at the highest reading on the scale. Next test each commutator bar with the adjacent bar until all bars have been checked. (Note: A reading of zero indicates an open circuit.)
2. Test the field by first putting the brushes aside so they do not touch any part of the starter:
   a. Remove the screw that attaches the solenoid point assembly brush head to the frame.
   b. Insert a piece of paper between the solenoid points.
   c. Connect one test prod to the terminal screw and one prod to the starter frame. If test lamp lights, the field windings are shorted and must be replaced.

Safety Note: Remove watches prior to conducting tests. Keep anyone with a heart "pacemaker" clear of the area.

LEARNING ACTIVITIES:

1. Read pages 5-24 to 5-25, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972.

2. Read the section on starting motors in the I&T Shop Manual or the manufacturer's service manual.

3. Complete the following questions:

   A. When should an armature be tested?
   B. What usually causes "open circuits" in the commutator?
   C. When can an open circuit in the armature be repaired?
   D. Should the test lamp light in the armature ground test? If it does light, what does it mean? If it does not, what does it mean?
   E. What would be a good indication of a shorted armature? How could you prove it?

4. Watch another student check the armature and fields of the starter.

5. Check the armature and fields of the starter on the designated tractor. Follow the steps in the Performance Guide.

CRITERION EVALUATION: All of the following procedures will be completed in an acceptable manner.

1. Completed ground test
2. Completed short test
3. Completed balance test
4. Tested field

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE STARTING CIRCUIT

COMPETENCY: Check ignition switch

PERFORMANCE OBJECTIVE: Given a set of screwdrivers, pliers, ignition wrenches, and a continuity tester or ohmmeter, check an ignition switch on the designated tractor.

PERFORMANCE GUIDE:

1. Disconnect all wires from switch (noting their position so they can be reconnected).
2. Attach continuity tester across "battery" and "ignition" terminals of the ignition switch.
3. Turn switch to "start" and check for contact. Shake switch to check for shorts.
4. Attach continuity tester across "battery" and "start" terminals of the switch.
5. Turn switch to "start" and check for contact.
6. Remove continuity tester and reconnect wires to switch or replace ignition switch if faulty.

LEARNING ACTIVITIES:

1. Read pages 7-15 to 7-17, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972.

2. Read pages 202, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

3. In the laboratory area, check the ignition switch on the designated tractor.

SUPPLEMENTAL READINGS:

1. Page 162, Fundamentals of Machine Operation-Tractors, Deere and Co., Moline, Ill., 1975.
2. Pages 427-437, Mechanics in Agriculture, Phipps, Second Edition, 1977.
3. I&T Shop Manual, Technical Publications, Inc., Kansas City, Mo.

CRITERION EVALUATION: The continuity-tester readings should agree with those of the instructor.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE STARTING CIRCUIT

COMPETENCY: Check safety switches

PERFORMANCE OBJECTIVE: Given a set of screwdrivers, pliers, ignition wrenches, and a continuity-tester ohmmeter, check the safety switch on the designated tractor.

PERFORMANCE GUIDE:

1. Disconnect wires from safety switch.
2. Attach continuity tester across switch terminals.
3. Activate switch and check for contact. If there is continuity, the safety switch is shorted.
4. Remove continuity tester and reconnect wires to safety switch.
5. Replace safety switch if faulty.

LEARNING ACTIVITIES:

1. Read pages 5-30 to 5-31, 7-15 to 7-17, and 2-3 to 2-7, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972.

2. Complete the following questions:

   A. Why must you always replace a defective switch with a switch of the same electrical rating?
   B. Give an example of a safety switch, and why it would be important to make sure it is operating correctly.
   C. List and define in your own words the three basic circuit failures.

3. Check the I&T Shop Manual or manufacturer's service manual for the correct allowable resistance of the switch.

4. In the laboratory area, check the safety switch on the tractor with the help of the Performance Guide.

CRITERION EVALUATION: The reading on the continuity tester or ohmmeter should agree with the instructor's reading.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE STARTING CIRCUIT

COMPETENCY: Check solenoid

PERFORMANCE OBJECTIVE: Given a set of ignition wrenches, an open-end wrench set, a D.C. voltmeter or a multi-meter, check a solenoid on the designated tractor.

PERFORMANCE GUIDE:

1. Disconnect solenoid-to-starter cable connection from the solenoid.
2. Connect voltmeter from starter terminal of the solenoid to ground.
3. Activate starter switch and observe reading on voltmeter for battery voltage.
4. Remove voltmeter and reconnect starter cable.

LEARNING ACTIVITIES:

1. Read page 7-14, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972.

2. Read pages 5-31 to 5-33, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972.

3. In the laboratory area, check the solenoid with the help of the Performance Guide.

SUPPLEMENTAL READING:

1. I&T Shop Manual, Technical Publications, Inc., Kansas City, Mo.

CRITERION EVALUATION: The voltmeter reading should agree with the instructor's reading.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE STARTING CIRCUIT

COMPETENCY: Replace bearings and bushings

PERFORMANCE OBJECTIVE: Given an open-end and a box-end wrench set, screwdrivers, bushing puller and driver set, an adjustable reamer, and specified bearing lubricant, replace the bearings and bushings on the designated starter.

PERFORMANCE GUIDE:

1. Disconnect battery ground.
2. Remove starter.
3. Dismantle starter (procedure varies for different starters).
4. Remove bushings with appropriate puller or driver.
5. Install new bushings with appropriate driver.
6. Check for free turning on end of armature shaft.
7. If shaft fits too tightly, ream the bushing until a free fit is obtained.
8. Oil and assemble the starter.
9. Bench test the starter to see that it runs freely, without excess play.
10. Reinstall starter and test for proper functioning.

LEARNING ACTIVITIES:

1. Read pages 5-27 to 5-28, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972.

2. Read the section on starters, for the assigned tractor, in either the I&T Shop Manual or the manufacturer's service manual.

3. After reading the assigned material complete the following questions:

   A. What will a badly worn bushing do to the starter motor?
   B. When should bronze bushings in the starter motor be oiled?
   C. When installing a bushing, how can you prevent it from collapsing?
   D. What type of lubricant would you use when installing new bearings?

4. In the shop area, replace the bearings and bushings on the assigned starter. Follow the steps in the Performance Guide and the service manuals.

CRITERION EVALUATION: The bushings will be installed without damage to other parts and the starter will function properly.

The following steps will have been completed:

1. Removed starter
2. Dismantled starter
3. Installed new bushings
4. Assembled starter
5. Bench tested starter
6. Installed and tested the starter on the tractor

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE STARTING CIRCUIT

COMPETENCY: Replace ring gear on the flywheel

PERFORMANCE OBJECTIVE: Given ring gear, complete tool set, and oven or torch to heat ring gear, replace the ring gear on the flywheel of the designated tractor.

PERFORMANCE GUIDE:

1. Remove flywheel. (This generally requires the removal of the clutch from the flywheel.)
2. Remove old ring gear with hammer and chisel or torch, being careful not to damage the flywheel.
3. Heat new ring gear in the oven until it expands enough to slip easily on the flywheel.
4. Install ring gear on flywheel with rounded end of gear teeth toward the starter.
5. Reinstall flywheel.

LEARNING ACTIVITIES:

1. Read page 2-62, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972, and answer the following questions:

   A. When removing the ring gear, why should you use the hammer and punch around the entire circumference of the gear?
   B. When heating the gear why should you be very careful not to overheat it?
   C. If the gear can not be tapped into place easily what should you do?

2. Study the section on installing ring gears in the I&T Shop Manual or manufacturer's service manual.

3. In the shop area, replace the ring gear on the flywheel of the assigned tractor.

CRITERION EVALUATION: The ring gear will be installed without damage to any other parts (except the old ring gear) and the starter will function properly.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE STARTING CIRCUIT

COMPETENCY: Replace starter drive

PERFORMANCE OBJECTIVE: Given a new starter drive and a tool set, replace the starter drive on the designated tractor.

PERFORMANCE GUIDE:

1. Disconnect the battery ground.
2. Remove starter.
3. Remove starter drive (Bendix) from starter shaft.
4. Install new drive on starter shaft; reassemble starter if necessary.
5. Reinstall starter.
6. Reconnect battery ground.
7. Check operation of starter.

LEARNING ACTIVITIES:

1. Read pages 5-23 to 5-24, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972.

2. Complete the following questions:

   A. When should you replace the starter drive?
   B. Describe the steps you should follow when installing a new drive spring.

3. Read the section on starters for the designated tractor in either the manufacturer's service manual or the I&T Shop Manual.

4. In the shop area replace the starter drive on the assigned tractor. Follow the steps outlined in the Performance Guide.

CRITERION EVALUATION: All of the following steps must be completed acceptably.

1. Removed starter
2. Removed starter drive
3. Installed new drive
4. Installed starter
5. Checked operation of starter

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE STARTING CIRCUIT

COMPETENCY: Replace starter brushes

PERFORMANCE OBJECTIVE: Using the designated engine, a mechanic's tool set, [illegible] inch/pound torque wrench and new starter brushes, [illegible]lace the starter brushes.

PERFORMANCE GUIDE:

1. Take all brushes out of their retainers and hang them outside of starter frame.
2. Put starter drive-yoke return-spring into recess of drive-end housing and install housing to starter frame.
3. Install brush end plate with end-plate boss aligned with starter-frame slot and install the through bolts. Tighten to 55-75 inch-pounds torque. (Make sure that stop-ring retainer is correctly seated in the drive-end housing.)
4. With a hook, pull back on the brush springs and insert the brushes into their holders.
5. Cover the brush openings with water-proof tape. Install the drive-yoke cover and gasket. Install the brush cover bank and tighten the retaining screw.
6. Lubricate the drive end of the armature and install drive-end housing seal using a socket or other suitable tool.
7. Connect starter to battery, being careful not to over-tighten cable, and check operation.

LEARNING ACTIVITIES:

1. Read pages 104-107, Tractor Maintenance, AAVIM, 1975.

2. Read page 122-123, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

3. Read pages 5-27 and 5-29, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972.

4. Complete the following questions:

   A. Describe why, how, and when you would "seat" a starter brush.
   B. Why should you always use matched sets when replacing starter motor brushes?
   C. When should you check the spring tension of the brushes?

5. In the shop area, replace the starter brushes on the assigned tractor. Follow the steps outlined in the Performance Guide.

SUPPLEMENTAL READINGS:

1. Page D-119-F, Diesel Engine Mechanics, William A. Foutes, Developed by the Mid-American Vocational Curriculum Consortium, Inc.
2. I&T Shop Manual, Technical Publications Inc.

CRITERION EVALUATION: There will be no damage to any parts, all parts will be torqued to specifications, and the starter will operate when current is supplied.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE STARTING CIRCUIT

COMPETENCY: Replace starter motor solenoid

PERFORMANCE OBJECTIVE: Given the necessary replacement parts, a manufacturer's service manual, and mechanic tool set, replace a starter motor solenoid.

PERFORMANCE GUIDE: NOTE: The starter motor solenoid is usually a "built-in" component. Check the service manual for specific instructions.

Solenoid contact assembly replacement:

1. Remove the starter components as outlined in the service manual, identifying parts during disassembly to facilitate reassembly.
2. Unsolder the contact post from the field coil connecting strap, using a heavy duty soldering iron or a small flame propane torch.
3. Cut off the head of the contact-spring retaining rivet with a sharp chisel and throw away the contact spring. (Use an 8-32" N.C. tap to cut threads in the rivet hole.)
4. Remove the contact post retaining screw and insulating washer; discard both.
5. Put the new contact spring and ground brush assembly, paper insulator, and contact post in position on the starter frame.
6. Install the insulating washer and retaining screw. Center the contact points and tighten the retaining screw securely. Stake the threaded end of the screw from inside the starter frame to manufacturer's specifications.
7. Clean the end of the field connecting strap and the slotted area of the contact post with fine sandpaper.
8. Insert the end of the field connector strap through the slot of the contact post and bend the end of the connector strap against the clean surface of the contact post.
9. Solder the connection with rosin-core solder.
10. Remove the upper ground brush retaining screw and discard the brush.
11. Place the field ground lead terminal and new ground brush terminal block together and install the original retaining screw.
12. Install the armature and drive assembly, drive yoke, and drive yoke pivot pin. Add a few drops of oil to both ends of the armature shaft.

13. Slide the stop ring retainer into place on the armature shaft and position the drive yoke return spring in the drive-end housing; then install the housing to the starter frame.
14. Install the end plate and the through bolts, and tighten securely. Insert the brushes in their holders.
15. Press on the starter drive yoke until the movable pole shoe is bottomed. Check the clearance between the new contact points and adjust to a .020 - .100 clearance.
16. Install protective tape over the brush openings of the starter frame, then install the drive yoke cover and gasket, and the brush cover band.
17. Install and tighten the brush-cover-band retaining screw.

LEARNING ACTIVITIES:

1. Read the section on starters in the I&T Shop Manual or manufacturer's service manual for the designated tractor.

2. Read pages 5-31 to 5-32, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972.

3. Replace the starter motor solenoid on the assigned starter motor. Follow the steps outlined in the Performance Guide or service manual.

CRITERION EVALUATION: The disassembly and reassembly order will follow the steps outlined in the service manual. There will be no damage to any parts and the solenoid will operate according to manufacturer's specifications.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE STARTING CIRCUIT

COMPETENCY: Replace starter motors

PERFORMANCE OBJECTIVE: Given an open-end and box-end wrench set, a socket set, and a new starter, replace the starter motor on the designated tractor.

PERFORMANCE GUIDE:

1. Disconnect battery ground cable.
2. Disconnect cable from starter.
3. Unbolt starter from engine.
4. Compare old starter with replacement starter to be sure of correct fit.
5. Thoroughly clean mount area for good grounding.
6. Bolt on replacement starter.
7. Replace starter cable.
8. Replace battery ground cable.
9. Check for correct operation.

LEARNING ACTIVITIES:

1. Read the section on starters for the assigned tractor in either the I&T Shop Manual, or the manufacturer's service manual.

2. Remove and install the starter motor on the assigned tractor. Follow the outline given in the service manuals and the Performance Guide.

CRITERION EVALUATION: The starter will fit correctly, be fastened securely, and all connections will fit tightly. The replacement process will include the acceptable completion of all the following steps:

1. Disconnected starter
2. Removed starter from engine
3. Installed new starter
4. Replaced cables.
5. Checked correct operation

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING THE STARTING CIRCUIT

COMPETENCY: Turn armature on a starter

PERFORMANCE OBJECTIVE: Given a mechanic's tool set, an armature tester (growler) a continuity tester, and a metal lathe with mica undercutting attachment, turn an armature.

PERFORMANCE GUIDE:

1. Dismantle the starter.
2. Check armature for shorts, grounds, or open windings.
3. Place armature in lathe.
4. Remove only enough material to true and "clean up" commutator.
5. Undercut mica between commutator bars 1/64" deep and .002" wider than mica.
6. Clean all burrs off commutator.
7. Check armature again for shorts, grounds, or open wiring.
8. Reassemble starter.

LEARNING ACTIVITIES:

1. Read pages 5-25 to 5-26, Fundamentals of Service-Electrical Systems, Deere and Co., Moline, Ill., 1972.

2. Read the section on starters for the assigned tractor in either the I&T Shop Manual or the manufacturer's service manual.

3. Have the instructor demonstrate how to use the tool for undercutting or use the metal lathe if one is not available.

4. In the laboratory area, turn the armature on a starter. Follow the steps outlined in the Performance Guide.

SUPPLEMENTAL READING:

1. Pages D-127-F to D-129-F, Diesel Engine Mechanics, William A. Foutes, Mid-America Vocational Curriculum Consortium, Inc., 1977

CRITERION EVALUATION: The turning process should include the acceptable completion of all the following steps:

1. Turned and cleaned commutator
2. Undercut mica between commutator bars
3. Removed burrs
4. Eliminated shorts, grounds, and open wiring
5. Correctly reassembled starter

SECTION VIII Maintaining and Servicing Gasoline Fuel System

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STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING GASOLINE FUEL SYSTEM

COMPETENCY: Adjust carburetor float

PERFORMANCE OBJECTIVE: Given the manufacturer's service manual, end wrenches, screw driver, pliers and a ruler, adjust a carburetor float.

PERFORMANCE GUIDE:

1. Shut off fuel valve under fuel tank and remove carburetor from tractor.
2. Remove screws from top of carburetor and lift top half of carburetor from carburetor bowl.
3. Lay top half of carburetor upside down in a vise or on the work bench. (At this point the float will be in the top side of the carburetor.)
4. Remove pin holding float to the carburetor. Visually inspect the float for holes. Shake the float to see if there is any gasoline inside the float. (If gasoline is inside float, discard it and replace with a new one.)
5. Replace the float and with a ruler measure the distance from the carburetor top to the top of the float. Check service manual for correct height and adjust distance accordingly. (If carburetor is being rebuilt, the rebuilding kit comes with a preset float gauge.) Bend the float shaft up or down to reach desired height.

LEARNING ACTIVITIES:

1. Read pages 42-43, Fundamentals of Machine Operation - Preventive Maintenance, Deere and Co., Moline, Ill., 1973, and answer the following questions.

   A. Describe how you could check a carburetor float for leaks.
   B. When should you adjust the carburetor float?
   C. Use a special _____ _____ tool to adjust the float when recommended.

2. See the I&T Shop Manual for the correct carburetor float height for the tractor you are working on.

3. Adjust the carburetor float height with the help of the performance guide.

SUPPLEMENTAL READINGS:

1. Pages 3-16 to 3-17, Fundamentals of Service - Engines, Deere and Co., Moline, Ill., 1972.

2. Pages 413-421, Mechanics in Agriculture, LLoyd J. Phipps, Second Edition, Interstate Publishers, 1977.

CRITERION EVALUATION: The float will be adjusted to the right height as checked with a ruler, and engine will run smoothly after carburetor has been reassembled and installed. After engine has run and been turned off, the gasoline will not overflow in the carburetor bowl.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING GASOLINE FUEL SYSTEM

COMPETENCY: Adjust carburetor idle/fuel mixture

PERFORMANCE OBJECTIVE: Given a screwdriver, adjust the carburetor idle air/fuel mixture

PERFORMANCE GUIDE:

1. Check engine air cleaner and make sure that the engine can get clean, nonrestricted air.
2. Start engine and let warm up to normal operating temperature.
3. Turn idle adjustment screw in until the engine begins to run irregularly.
4. Turn the screw in the opposite direction until engine once again runs irregularly.
5. Turn the screw clockwise and counter clockwise until engine begins to run smoothly.
6. Advance the throttle two or three times and then let the engine return to idle speed.
7. Check setting with tachometer.

Note: If the engine continues to run smoothly and there is no black smoke from the exhaust, the adjustment is correct. Otherwise, further idle speed screw adjustment is indicated.

LEARNING ACTIVITIES:

1. Read pages 75-77, Tractor Maintenance, AAVIM 1975, and complete the following questions.

   A. Name four steps you would use when adjusting the idling air mixture if a dwell tachometer is not available.
   B. Identify the following items on a carburetor.
      1. Idle-speed adjustment
      2. Idle-mixture adjustment
      3. High-speed load adjustment
      4. Drain plug

2. If you have trouble completing the above activity and need more information or if the instructor directs, read pages 41-42, Fundamentals of Machine Operation - Preventive Maintenance.

   A. What does the idle mixture adjusting screw do? Explain the affect on engine operation when the idle mixture adjusting screw is turned in and/or out.
   B. If the engine operation is not affected by one or two complete turns of the adjusting screw what might be the problem?
   C. Air/fuel mixtures adjusted too lean may result in damaged _____.

3. Check the I&T Shop Manual for the correct procedure when adjusting your tractor's carburetor idle air/fuel mixture.

4. With the help of the Performance Guide, adjust the carburetor idle air/fuel mixture.

SUPPLEMENTAL READINGS:

1. Pages 3-8 to 3-19, Fundamentals of Service - Engines, Deere and Co., Moline, Ill., 1972.
2. Pages 363-365, Farm Mechanics Text and Handbook, Phipps, McColly, Scranton and Cook, Interstate Publishers, 1954.

CRITERION EVALUATION: When the carburetor is properly adjusted, the engine will run smoothly and no black smoke will come from the exhaust.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING GASOLINE FUEL SYSTEM

COMPETENCY: Adjust the engine idle speed

PERFORMANCE OBJECTIVE: Given the manufacturer's operator's manual and a screwdriver, adjust the engine idle speed. Check hour meter and compare with recommended RPM's in operator's manual.

PERFORMANCE GUIDE:

1. Check air cleaner for dirt and clogged passages. Make sure air flow is not restricted to the carburetor.
2. Start engine and warm to normal operating temperature.
3. Turn engine idle screw in and out to increase or decrease engine speed.
4. Check engine speed with tachometer.

Note: Most tractors should idle at from 500-700 RPM's. This can be adjusted by looking at the hour meter to check engine speed. If no hour meter exists, turn the idle screw until the engine runs smoothly, but not so slow that the engine dies when put into gear, and/or moves at idle speed.

LEARNING ACTIVITIES:

1. Read pages 74-75, Tractor Maintenance, AAVIM, 1975 and answer the following questions.

   A. What is the function or job of the bumper screw?
   B. What would happen to the engine if the bumper screw worked loose?
   C. What is another name for the bumper screw?
   D. Turning the bumper screw _____ increases engine speed; turning it _____ _____ decreases it.

2. Check your operator's manual, or "Farm Tractor Tune-Up and Service Specifications, AAVIM 1972 for the proper idling speed.

3. Read pages 40-41, Fundamentals of Machine Operation - Preventive Maintenance, Deere and Co., Moline, Ill., 1973 and complete the following questions:

   A. What should you do before making any carburetor adjustments?
   B. When is the recommended time to check and make carburetor adjustments on a tractor engine?
   C. Describe how you would check for air leaks at the manifold connections and around the carburetor gaskets.

D. If the carburetor has a strainer screen what should you check for?
E. Why should you clean the strainer screen and check for air leaks before attempting to adjust the carburetor?
F. What is the name of the instrument used on some tractors to set the engine speed?

4. Obtain the necessary tools and the manufacturer's operator's manual, adjust the engine idle speed on the designated tractor.

SUPPLEMENTAL READINGS:

1. Pages 3-16 to 3-19, Fundamentals of Service - Engines, Deere and Co., Moline, Ill., 1972.
2. I & T Shop Manual, Technical Publications, Incorporated, Kansas City, MO.
3. Pages 363-364, Farm Mechanics Text and Handbook, Phipps, McCally, Sranten, and Cook, 1954, Interstate Publishers.

CRITERION EVALUATION: If there is no hour meter, the tractor should move at idle speed when in first and second gear. The engine should run smoothly when the job is completed.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING GASOLINE FUEL SYSTEM

COMPETENCY: Clean the carburetor

PERFORMANCE OBJECTIVE: Given end wrenches, screwdrivers, clean rags, solvent, safety glasses or face shield, and an air hose, clean the carburetor on a gasoline-powered tractor.

PERFORMANCE GUIDE:

1. Shut off fuel valve under fuel tank and remove carburetor from engine.
2. Remove screws from top of carburetor.
3. With a clean rag, wipe all dirt and sludge from the carburetor top, float, needle, valve and seat, inside and out. Put on safety glasses and with an air hose blow dirt from top half, including jets and crevices.
4. Replace needle valve, seat and float assembly. Check float adjustment
5. Clean the bottom half of the carburetor of gasoline, water, rust, etc., scraping with a knife if needed. Blow out with air hose making sure no jets, holes, tubes, etc., are plugged.

   NOTE: If jets cannot be cleaned with air hose, jet can be removed with screwdriver for further cleaning. Use care to avoid enlarging jets or passages.

6. Reassemble, replacing gaskets if needed.
7. Install carburetor, start engine and adjust.

LEARNING ACTIVITIES:

1. With the help of the Performance Guide clean the carburetor on the designated tractor.

2. Consult the appropriate I&T Shop Manual for directions for dismantling a carburetor.

SUPPLEMENTAL READINGS:

1. Pages 363-364, Farm Mechanics Text and Handbook, Phipps, McColly, Sranton, and Cook, 1954.
2. Pages 3-16 and 3-17, Fundamentals of Service-Engines, Deere and Co., Moline, Ill.

CRITERION EVALUATION: Upon inspection the inside of the carburetor will be clean. No jets or holes will be plugged and the engine will operate properly.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING GASOLINE FUEL SYSTEM

COMPETENCY: Clean settling bulb (sediment bowl)

PERFORMANCE OBJECTIVE: Given a clean rag and a tractor with a settling bulb, clean the settling bulb.

PERFORMANCE GUIDE:

1. Turn off fuel at fuel shut-off valve.
2. Loosen set screw on wire bale at the bottom of settling bulb.
3. Remove bulb, gasket and screen (if there is one).
4. Carefully wipe the settling bulb and screen with clean rag.
5. Open shut-off valve slightly, allowing a small amount of fuel to flush out the top part of the settling bulb housing. Catch overflow in a suitable container.
6. Inspect bulb gasket for cuts or damage and replace if necessary. Replace screen, gasket and bulb. Tighten bulb with wire bale and set screw.
7. Turn on fuel and check for leaks.

LEARNING ACTIVITIES:

1. Read pages 68-70, Tractor Maintenance, and complete the following questions:

   A. Why should you remove the glass settling bowl with a twisting motion?
   B. What will happen if you tighten a disk-filter element too much?
   C. What should you use when washing the filter screen?

2. Read pages 48-50, Fundamentals of Machine Operation - Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

3. With the help of the Performance Guide, clean the settling bulb on the designated tractor.

SUPPLEMENTAL READINGS:

1. Page 3-7, Fundamentals of Service - Engines, Deere and Co., Moline, Ill., 1977.
2. Pages 14 and 15, Tractor Operation and Daily Care, AAVIM, 1970.
3. Pages 417-421, Mechanics in Agriculture, Lloyd J. Phipps, Second Edition, 1977, The Interstate Printers and Publishers.

CRITERION EVALUATION: Upon visual inspection, the bulb will be clean of dirt and foreign matter and there will be no leak around the gasket.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING GASOLINE FUEL SYSTEM

COMPETENCY: Install carburetor repair kit

PERFORMANCE OBJECTIVE: Given an assorted set of end wrenches, a service manual, screwdrivers, needle nose pliers, carburetor cleaner, and a dynamometer, install a carburetor repair kit on the designated tractor.

PERFORMANCE GUIDE:

1. Turn off fuel supply and remove carburetor from engine.
2. Remove screws from top of carburetor; remove carburetor float, needle, seat, and gasket from top half of carburetor.
3. Place the top and bottom halves of the carburetor into a can of carburetor-cleaning solution. Let stand for at least four hours.
4. Remove carburetor from cleaning solution and wash thoroughly with very hot water.
5. Take air hose and blow remaining water from the parts. Be sure to blow into all holes and corners.
6. Remove each jet (one-at-a-time) and replace with a new one. Remove throttle shaft and bushings and replace with new one. Follow the same procedure for the remaining new parts. After all new parts have been installed and float height adjusted, reassemble carburetor.
7. With carburetor reassembled, install on engine. Start engine and let run until reaching normal operating temperature. Make final idle adjustment.
8. To set load adjustment, put tractor on dynamometer and set load screw to specifications.

LEARNING ACTIVITIES:

1. Consult the I&T Shop Manual for the proper instructions for disassembly and reassembly of the carburetor.
2. Read the instructions accompanying the carburetor repair kit.
3. Read pages 74-77, Tractor Maintenance, AAVIM, 1975.
4. Install a carburetor repair kit on the assigned tractor.

SUPPLEMENTAL READINGS:

1. Pages 40-43, Fundamentals of Machine Operation - Preventive Maintenance.
2. Pages 3-16 to 3-17, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.
3. Pages 415-416, Mechanics in Agriculture, Lloyd J. Phipps, Second Edition, 1977, The Interstate Publishers, Inc.

CRITERION EVALUATION: The engine should run at service manual specifications. There should be no fuel leaks in the carburetor, with engine stopped, while idling, or under load. The actual work time should not exceed 1-1/2 hours, excluding time parts are in cleaning solution.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING GASOLINE FUEL SYSTEM

COMPETENCY: Replace fuel pump

PERFORMANCE OBJECTIVE: Given a new fuel pump, a set of flare-nut wrenches, a small socket set, an open-end wrench set, sealing compound and a putty knife or scraper, replace the fuel pump on the designated tractor.

PERFORMANCE GUIDE:

1. Turn off fuel.
2. Remove fuel lines from pump.
3. Unbolt pump from engine.
4. Clean area where gasket fits to engine.
5. Compare new pump to old one to insure a correct match.
6. Coat the gasket with appropriate sealing compound.
7. Install gasket and pump being certain that actuating arm bears correctly against cam or push rod. (May need to turn engine over to reduce cam pressure on actuating arm.)
8. Torque attachment bolts (if torque specs are available).
9. Reconnect fuel lines.
10. Turn on fuel and check for leaks.
11. Start engine and check for leaks.

LEARNING ACTIVITIES:

1. Consult the I&T Shop Manual for additional information needed when replacing the fuel pump.

2. Read pages 3-5 to 3-6, Fundamentals of Service - Engines, Deere and Co., Moline, Ill., 1972.

3. In the laboratory area, replace the fuel pump on the designated tractor with the help of the performance guide.

CRITERION EVALUATION: When completed, the pump will show no signs of leaks.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING GASOLINE FUEL SYSTEM

COMPETENCY: Service a fuel pump (diaphram type)

PERFORMANCE OBJECTIVE: Given assorted wrenches and screwdrivers, needle-nose pliers, and replacement parts if needed, service a fuel pump.

PERFORMANCE GUIDE:

1. Pull engine oil dipstick and smell oil for gasoline or diesel fuel. If oil is "thin" or "diluted" and/or dipstick indicates that the engine oil level is "overfull," this may indicate a hole in the pump diaphram.
2. Turn fuel supply off. Remove fuel lines to pump, and remove pump from engine.
3. Remove screws from top of fuel pump; lift top half of fuel pump off, being careful not to damage the diaphram.
4. Inspect the diaphram on the remaining half of the pump. Replace diaphram, if needed, and align with holes in pump body.
5. Replace top of fuel pump and tighten screws.
6. Replace fuel pump on engine, connect lines and turn on fuel valve.
7. Change diluted oil.
8. Start engine and let run for several minutes. Check for fuel and oil leaks.

Note: In the event the fuel pump is a scaled type, replace with new pump.

LEARNING ACTIVITIES:

1. Consult the I&T Shop Service Manual for additional information when servicing a fuel pump (diaphram type).

2. With the help of the performance guide, service the fuel pump on the designated tractor.

CRITERION EVALUATION: Upon inspection there will be no leaks nor fuel dilution, and the task will be performed within 5 minutes of the time stated by the instructor.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING GASOLINE FUEL SYSTEM

COMPETENCY: Service fuel tanks and fuel lines

PERFORMANCE OBJECTIVE: Given assorted wrenches and clean rags, service a fuel tank and fuel lines.

PERFORMANCE GUIDE:

1. Drain all the fuel from the fuel line.
2. Remove fuel shut-off valve from fuel tank.
3. Pour a quart of clean fuel into the tank, agitate the tank, and allow this fuel to run out of the tank. Repeat this procedure. Do not put these two quarts of fuel with the contents previously drained from the tank, as they will contain rust, water, and dirt. (Note: Tanks with stand pipes must be removed and inverted.)
4. Clean fuel shut-off valve and replace into tank.
5. Disconnect fuel line from the carburetor. Remove settling bulb and screen.
6. Pour a small amount of fuel into the tank and allow it to run through the settling bulb body.
7. Clean settling bulb, screen and replace.
8. Once again pour a small amount of fuel into the fuel tank and allow to run into the settling bulb through the fuel line to the disconnected point at the carburetor.

   Note: Some carburetors will have a screen at the point where the fuel line connects to the carburetor. Simply loosen the fitting into the carburetor and remove it. The screen will be attached to this fitting.

9. Replace screen in carburetor, connect fuel line, fill fuel tank with fuel. Check for leaks.

LEARNING ACTIVITIES:

1. Read pages 68-70, Tractor Maintenance, AAVIM 1975.

   A. Describe the procedure you would use in cleaning the sediment bowl and fuel filter.
   B. What is the difference between a disk filter and a screen filter? How do you clean each of them?
   C. What should you use to clean a filter?

2. Read pages 48-51, Fundamentals of Machine Operation - Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

3. Read pages 3-3 to 3-4, Fundamentals of Service - Engines, Deere and Co., Moline, Ill., 1972.

4. With the help of the Performance Guide service the fuel lines on the assigned tractor.

SUPPLEMENTAL READINGS:
1. Page 15, Tractor Operation and Daily Care, AAVIM 1972.
2. Pages 4-17 to 4-21, Mechanics in Agriculture, Lloyd J. Phipps, Second Edition, The Interstate Printers and Publishers, Inc.

CRITERION EVALUATION: There will be no dirt in the settling bulb (sediment bowl) and no leaks in the fuel valve, settling bulb, or fuel line connections.

SECTION IX Maintaining and Servicing Diesel Fuel System

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STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING DIESEL FUEL SYSTEM

COMPETENCY: Bleed a diesel fuel system

PERFORMANCE OBJECTIVE: Given the operator's manual, suitable wrenches, and diesel fuel, bleed the diesel fuel system on the designated tractor.

PERFORMANCE GUIDE:

1. Check operator's manual for each individual system's recommended bleeding order.
2. Check to make sure there is clean fuel in fuel tank.
3. Turn on fuel cut-off at tank.
4. Loosen bleed plugs at primary fuel filter.
5. Activate manual fuel pump lever on priming pump until clean fuel flows from filter.
6. Close primary bleed plug and open secondary fuel filter bleed plug.
7. Activate fuel pump lever on priming pump until clean fuel comes from secondary filter.
8. Close bleed plug and continue to operate fuel pump for 10-12 strokes.
9. Using appropriate wrenches, loosen injector high pressure lines at nozzle.
10. Turn engine over until fuel with no air comes out at connection.
11. Tighten lines and repeat procedure until all nozzle lines are bled.
12. Turn engine over and start.
13. If engine fails to start, repeat procedure to remove air left from first bleeding. If it still won't start, check for other possible causes of fuel problem. (See service manual.)

LEARNING ACTIVITIES:

1. Read pages 50-51, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

2. Read pages 113-114, Tractor Maintenance, AAVIM, 1975.

3. Check the I&T Shop Manual for the recommended bleeding procedure for your tractor's fuel system.

4. Bleed the diesel fuel system on the designated tractor.

SUPPLEMENTAL READING:

1. Pages 417-421, Mechanics in Agriculture, Lloyd J. Phipps, second edition, 1977, The Interstate Printers and Publishers, Inc.

CRITERION EVALUATION: The fuel system will be bled in such a way as to remove all air from the lines. There will be no damage to any parts and the engine will start.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING DIESEL FUEL SYSTEM

COMPETENCY: Service diesel fuel filters

PERFORMANCE OBJECTIVE: Given an operator's manual, replacement filters and gaskets, clean rags, and suitable wrenches, service the diesel fuel filters on the designated tractor.

PERFORMANCE GUIDE: NOTE: Since different tractors have different filtering systems, check the manufacturer's operator's manual for correct order and procedure. (Important: Always keep tools and parts clean of foreign materials.)

1. Obtain correct filter elements for make and model of machine.
2. Shut off fuel.
3. Remove primary filter, clean the container, and install new filter.
4. Remove old gasket and install new gasket found in new element kit.
5. Reinstall filter element and container on engine.
6. Tighten bolt to compress gasket (do not over-tighten--distortion of the container could result.)
7. Repeat procedures 3-6 with secondary filter.
8. Turn on fuel.
9. Bleed system and start engine.
10. Check filter for leaks and wipe off excess fuel to prevent dust accumulation.

LEARNING ACTIVITIES:

1. Read pages 108-114, Tractor Maintenance, AAVIM, 1975.

2. Read pages 50-51, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

3. Complete the following questions:

   A. Normally, a first-stage filter should be changed every _____ hours, and the second-stage filter every _____ hours.
   B. What can be used to determine whether of not you have to change the fuel filter more frequently?
   C. Why should you always bleed the fuel lines after new filter elements are installed? What could happen if you don't?
   D. List the steps you would use when bleeding fuel lines.

4. Service the diesel fuel filters on the designated tractor with the help of the manufacturer's operator's manual and Performance Guide.

SUPPLEMENTAL READINGS:

1. Page 15, Tractor Operation and Daily Care, AAVIM, 1970.
2. Page 3-7, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.
3. Page 40, Fundamentals of Machine Operation-Tractors, Deere and Co., Moline, Ill., 1974.

CRITERION EVALUATION: The fuel system will be clean. There will be no leaks. The system will be properly bled, and the engine will start.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING DIESEL FUEL SYSTEM

COMPETENCY: Service a diesel fuel injector

PERFORMANCE OBJECTIVE: Given a Roosa-Master tool set for service of nozzles, an injector nozzle popper, appropriate fittings, and a service manual, service a diesel fuel injector.

PERFORMANCE GUIDE:

1. Remove faulty injector from engine.
2. Clean unit in clean diesel fuel.
3. Remove carbon dam seal and sealing washer.
4. Remove carbon from tip with brass wire brush.
5. Insert nozzle in holding fixture and insert in vise.
6. Loosen lock nut and remove pressure adjusting screw, washer, and spring.
7. Remove nozzle valve from body. If nut came out easily, use retractor tool No. 16481. (Never mix nozzle bodies and valves. Keep in matched sets.)
8. Clean slip opening with 0.008 cleaning needle in pin vise. Clean up to size of opening. (You may have to start with .003 or .004 and work up to desired size.)
9. Clean seat with valve tip scraper.
10. Use sac hole drill to remove carbon from sac hole.
11. Polish guide to body. If necessary, use a small amount of Roosa-Master No. 16489 lapping compound.
12. Clean lapping compound out completely and reassemble nozzle. Back lift adjusting screw out several turns to prevent bottoming during reassembly.
13. Install on a nozzle tester to set opening pressure, pattern, and leak off. (Important: When testing nozzle, do not let any skin come in contact with spray from nozzle. There is sufficient pressure to puncture skin and cause blood poisoning.)
14. Check manufacturer's specifications for correct opening pressure, leak off, and other requirements.
15. Operate the tester to remove all air, and pump the lever at about 60 strokes per minute.
16. Observe spray pattern and nozzle sound. (There should be no long streaks of fuel on holes and the nozzle should give a distinctive chatter of the valve closing.)
17. Pump the lever until the nozzle just begins to open and note the pressure.
18. Turn in and out adjusting screw until correct opening pressure is obtained.
19. Turn valve lift adjusting screw until it just begins to bottom and then back out until the correct nozzle lift is obtained.

20. Lock nozzle nut down to correct torque.
21. Check for seat leakage;
    a. Bring nozzle up to approximately 1500 PSI and observe. (No fuel should leak from tip of nozzle.)
    b. Raise pressure to 2400 PSI and observe seat. (Moisture is acceptable but no drop should form in 10 seconds.)
22. Tilt the nozzle tip above horizontal and bring pressure up to 1500 PSI. Observe top end of nozzle and see if leakage is within specifications for the time.
23. Install new carbon dam seals and top seals with appropriate tool.
24. Reinstall nozzle into system if all checks are correct. Bleed system and start engine.

LEARNING ACTIVITIES:

1. Read pages 5-29 to 5-33, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972, and complete the following:

   A. What are two jobs the injection nozzle must do?
   B. What are three things that you can test nozzles for?
   C. List three things that you need to remember when attempting to service the nozzle.
   D. Should you use a steel wire brush when cleaning the nozzle? Why or Why not?

2. In the shop area, using the Performance Guide and the I&T Shop Manual, service a diesel fuel injector.

SUPPLEMENTAL READINGS:

1. Pages 276-280, Diesel and High Compression Gas Engines, 3rd edition, E. J. Kates and William E. Luck, American Technical Society, Chicago.
2. Chapter 8, Diesel Fundamentals, Service, Repair, William K. Toboldt, The Goodheart-Wilcox Company, Inc., 1977.
3. Pages D-195-E to D-211-E, Diesel Engine Mechanics, William A. Fouts, Mid-America Vocational Curriculum Consortium, Inc., 1977.

CRITERION EVALUATION: All parts will fit correctly. There will be no leaks and the nozzle will operate at pressure specified in service manual.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING DIESEL FUEL SYSTEM

COMPETENCY: Service the diesel-injection pump

PERFORMANCE OBJECTIVE: Given appropriate wrenches, a strobelight tachometer and other special tools to check timing for the pump, service a diesel-injection pump for minor adjustments.

PERFORMANCE GUIDE:

NOTE: Service of a diesel-injection pump requires special schooling and much precise equipment so most dealers have this work done at special diesel shops. Below are some basic tasks a dealer might find necessary when servicing an injection pump in his shop. Caution: Never attempt to increase the fuel to an engine unless the correct equipment is used to do the job to exact specifications. Also, never loosen a pump while the engine is turning. It could shift position and cause serious damage to hand and arm.

1. Check the manufacturer's specifications for the engine at high idle, low idle, and basic engine timing.
2. Rotate the engine until the correct degree of timing comes up at the flywheel or front pulley.
3. Remove the plug at the pump or the plate on the pump to see if the timing marks are in line.
4. If timing marks are not in line, loosen retaining bolts and rotate the pump clockwise or counter clockwise until the marks are exactly in line.
5. Tighten the pump bolts and start the engine.
6. With a strobe tachometer, take a reading of the engine RPM at low idle, compare with the specifications.
7. Rotate the low-idle stop of the governor control until the correct low idle is reached. Lock the low-idle screw down and install a sealing wire to prevent future movement.
8. Move the fuel control lever to high idle and compare the tachometer reading with the manufacturer's specifications.
9. Move the high-idleadjustment screw until the manufacturer's recommended setting is reached and lock down with jam nuts. Install a locking wire to prevent further movement.
10. Operate the engine at high idle and check for loose fittings and leaky lines.

LEARNING ACTIVITIES:

1. Read pages 3-5 to 3-7, 5-8 to 5-16, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Complete the Self-test - Understanding a Diesel Transfer Pump, supplied by your instructor.

3. Using the Performance Guide and the manufacturer's service manual, service the designated diesel-injection pump for minor adjustments.

SUPPLEMENTAL READINGS:

1. Pages D-25-E to D-100-E, Diesel Engine Mechanics, William A. Foutes, Mid-American Vocational Curriculum Consortium, Inc., 1977.
2. Pages 56-59, Diesel Fundamentals, Service, Repair, The Goodheart-Wilcox Company, Inc., 1977.

CRITERION EVALUATION: Timing will be set to manufacturer's specifications. High and low idle, as checked by the instructor, will be within 5% of the manufacturer's specifications.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING DIESEL FUEL SYSTEM

COMPETENCY: Service a diesel-transfer pump

PERFORMANCE OBJECTIVE: Given a Roosa-Master service manual, screwdrivers, a micrometer, and a torque wrench, service the diesel-transfer pump on the designated tractor.

PERFORMANCE GUIDE:

1. Clean pump and work area completely.
2. Remove hydraulic head assembly.
3. Remove end plate.
4. Remove end-plate seal located on top of the end-plate sleeve with a dull scribe.
5. Remove sleeve with a Roosa-Master tool #1704. Use rotary motion to prevent damage of O-Ring seal on sleeve.
6. Remove priming by-pass spring at bottom of sleeve bore.
7. Remove transfer pump seal O-ring.
8. Remove transfer pump liner from pump. Remove pump blades, being careful not to lose any attached springs.
9. Wash transfer pump in clean fuel oil.
10. Check pump liner and blades for scratches which could cause problems.
11. If blades are unbroken, measure with micrometer (minimum width is 1.0930"). If width is incorrect, replace both blades.
12. Insert priming by-pass spring into end plate.
13. Place plunger in end-plate sleeve and shake to be sure plunger is free to move in bore.
14. Using twisting motion to prevent seal damage, insert sleeve into end plate with Roosa-Master tool #1704.
15. Assemble regulating spring in bore; install end-plate plug and tighten.
16. Wash transfer pump liner and place in position.
17. Insert blades carefully with one vertical and the other horizontal.
18. Install end-plate sealing ring.
19. Turn liner so notched slot will align with roll pin in end-plate assembly. Install end-plate assembly.
20. Insert screws and tighten to 36-39 in.-lbs.
21. Reinstall fuel lines and bleed system.
22. Check fuel pump pressure if problems exist. (Should not exceed 130 lbs. and should be a minimum of 18-22 PSI at 225 pump RPM).

LEARNING ACTIVITIES:

1. Read pages 3-5 to 3-7, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Complete the following:

   A. What is the purpose of a diesel transfer pump?
   B. List two basic types of fuel transfer pumps.
   C. What usually causes diesel transfer pumps to break down?

3. Using the Performance Guide and the Roosa-Master service manual, service the diesel transfer pump.

SUPPLEMENTAL READING:

1. Pages 256-257, Diesel Fundamentals, Service, Repair, Bill Toboldt, The Goodheart-Wilcox Company, Inc., 1977.
2. Page 259, Diesel and High Compression Gas Engines, E. J. Kates and W. F. Luck, 3rd Edition, American Technical Society, Chicago, 1975.

CRITERION EVALUATION: The removal and reinstallation will meet Roosa-Master specifications for its fuel transfer pump. The job will take no more than one hour.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING DIESEL FUEL SYSTEM

COMPETENCY: Service turbochargers

PERFORMANCE OBJECTIVE: Given the service manual, a set of mechanic's tools, a gasket scraper, torque wrench, and dial indicator with plugger extension, service the turbocharger on the designated tractor.

PERFORMANCE GUIDE: NOTE: Internal service of a turbocharger is not recommended. Most service is done with a new or rebuilt unit.

1. Remove air intake lines from turbocharger.
2. Remove adapter, air lines, exhaust elbow and other loose connections.
3. Unbolt turbocharger and remove from exhaust manifold.
4. Clean manifold completely of old gasket.
5. Inspect the blades of the turbocharger through the housing and end openings. (Blades should not be bent or broken because this causes problems in balance.)
6. Using a dial indicator with plunger extension, check radial bearing play through air outlet port while moving both ends of turbine shaft equally.
7. Check shaft end-play with dial indicator. If side or end-play exceeds manufacturer's specifications, replace the unit.
8. Replace the turbocharger on the exhaust manifold with a new gasket installed. Torque to specified tightness.
9. Reinstall air lines, outlet lines, and adapter between turbocharger and exhaust elbow. Make sure parts are aligned perfectly, adapter rotates freely and adapter has at least 1/16" free play.
10. Put air lines back on turbocharger and check all connections for tightness. (Note: Never start the reworked turbocharger until there is engine oil in the turbocharger bearing.)
11. Pull the engine stop and crank the engine until the air pressure gauge shows a working range of oil pressure.
12. Start engine and let run at 1000 RPM for 5 minutes to make sure bearing is well lubricated before operating at high idle.

LEARNING ACTIVITIES:

1. Read pages 16-17 of Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1972.

2. Read pages 6-14 to 6-16, 6-20 to 6-22, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

3. Complete the following questions:

   A. What is a turbocharger?
   B. What is the function of a turbocharger?
   C. Periodic inspection of a turbocharger should involve what six steps?

4. Using the Performance Guide and the I & T Shop Manual, replace or reinstall the turbocharger on the designated tractor.

SUPPLEMENTAL READING:

1. Pages 297-298, Diesel Fundamentals, Service, Repair, Bill Toboldt, The Goodheart-Wilcox Company, Inc., 1977.

CRITERION EVALUATION: Replaced or reinstalled unit will meet manufacturer's specifications. All of the following steps will be completed with 100% accuracy.

1. Removed turbocharger
2. Cleaned manifold connection
3. Inspected blades
4. Checked radial bearing play
5. Checked shaft play
6. Reinstalled turbocharger
7. Checked all connections

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING DIESEL FUEL SYSTEM

COMPETENCY: Time fuel injector pump to engine

PERFORMANCE OBJECIIVE: Given a tractor engine, necessary wrenches, and service manual, time the fuel injector pump on the engine.

PERFORMANCE GUIDE:

1. Check manufacturer's specifications for timing of make and model of tractor. (Information below is for a Robert Bosch in-line fuel injector pump.)
2. Remove No. 1 injector and make sure cylinder is on compression stroke.
3. Rotate engine until timing mark on flywheel is correct and timing line on pump gear drive can be seen in timing plug hole.
4. Align pump timing mark and rotate the pump gear counter clockwise approximately one tooth so that gears will match correctly when pump is installed.
5. Install pump and install retaining cap screws lightly.
6. Rotate pump in slotted holes to align timing marks exactly and tighten cap screws to recommended torque.
7. Install lines and controls to pump.
8. Bleed fuel system.
9. Start engine and check for leaks.

LEARNING ACTIVITIES:

1. Read the section on timing the fuel injection pump in the I&T Shop Manual for the designated tractor.

2. Practice timing a fuel injector pump on the designated tractor. Use the procedure in the Performance Guide for any help that you may need.

SUPPLEMENTAL READING:

1. Page 305, Diesel Fundamentals, Service, Repair, Bill Toboldt, The Goodheart-Wilcox Company, Inc., 1977.

CRITERION EVALUATION: The reinstalled pump will be timed to within one-half degree of the teacher's reading and the specifications given in the operator's manual.

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STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Adjust valve clearance

PERFORMANCE OBJECTIVE: Given a mechanic's tool set, tappet wrench, service manual, and a crank, adjust the valve clearance on the designated tractor.

PERFORMANCE GUIDE:

1. Some valves may be adjusted hot while others are adjusted cold. (See manufacturer's specifications)
2. Crank engine to bring number one piston to top dead center (T.D.C.) on the compression stroke.
3. Adjust both intake and exhaust valves of the number one cylinder to specifications with feeler (thickness) gauge, tappet wrench, and screwdriver.
4. Crank engine to bring next cylinder in firing order to T.D.C. of the compression stroke. Adjust those valves. Do the same for each succeeding cylinder in the firing order.
5. Reinstall valve cover, etc.

LEARNING ACTIVITIES:

1. Read pages 45-53, Tractor Maintenance, AAVIM, 1973.

2. Read pages 2-22 to 2-23, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1973.

3. Read pages 12-10 to 12-11, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

4. Complete the following questions:

   A. Give 5 reasons for proper valve-clearance adjustment.
   B. What will happen if there is little or no valve clearance?
   C. What will happen if there is too much valve clearance?
   D. What is valve clearance and why is it so important?
   E. Why is an exhaust valve given more clearance than the intake valve?
   F. How would you change the valve-tappet clearance?

5. Identify the firing order on a 2 cylinder engine. Do the same for a 4 cylinder engine and a 6 cylinder engine.

6. Adjust the valves on the designated tractor. Follow the suggested steps given in the Performance Guide.

SUPPLEMENTAL READING:

1. Pages D-109-C to D-110-C, Diesel Engine Mechanics, William A. Foutes, Mid-America Vocational Curriculum Consortium, Inc.
2. Pages 437-438, Mechanics in Agriculture, Lloyd J. Phipps, Second Edition, The Interstate Printers and Publishers, Inc., Danville, Ill., 1977.
3. Pages 9-11, Tractor Engine Tune-Up, West Virginia University Publication, 1973.
4. I&T Shop Manual, Technical Publications, Inc., Kansas City, Mo.

CRITERION EVALUATION: The valves will be adjusted to the manufacturer's specifications.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Check cylinder head and block for warpage

PERFORMANCE OBJECTIVE: Given a cylinder head and block, a straight-edge, and a feeler gauge, check cylinder head and block for warpage and mark all excessive warpage.

PERFORMANCE GUIDE:

1. Remove and clean the head.
2. Lay a straight-edge across the head.
3. Check with feeler gauge under straight-edge for clearance. (Generally the clearance must not exceed .001" per one inch, .003" per six inches, or .008" for the complete length of the head.)
4. Check mating surface of the block in the same way.
5. Mark all excessive warpage.

LEARNING ACTIVITIES:

1. Read pages 2-3 to 2-4, 2-24 to 2-25, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Answer the following questions:

   A. Describe how you would remove the cylinder head for the assigned tractor.
   B. What causes a cylinder head to warp?

3. Check the I&T Shop Manual or other engine technical manual for refacing limits.

4. Check the cylinder head and engine block on the designated tractor.

SUPPLEMENTAL READINGS:

1. Page 272, Diesel Fundamentals, Service, Repair, William K. Toboldt, The Goodheart-Willcox Co., Inc., South Holland, Ill., 1973.
2. Pages D-25-C to D-29-C, Diesel Engine Mechanics, William A. Foutes, Mid-America Vocational Curriculum Consortium, Inc., 1977.

CRITERION EVALUATION: All excessive warpage will be marked. The marked warpage of the cylinder head will include all warped portions that exceed .001 per one inch, .003 per six inches, or .008 for the complete length of the head.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Clean cylinder block, oil passages, and piston

PERFORMANCE OBJECTIVE: Given a parts-cleaning tank, clean the cylinder block, oil passages, and pistons on the designated tractor.

PERFORMANCE GUIDE:

1. Put on safety equipment.
2. With engine completely disassembled, wash all mechanical parts in parts-cleaning tank.
3. Scrape and brush dirt and carbon deposits from block, head, pistons, etc., being careful not to remove any metal from the parts being cleaned.
4. Blow out all oil passages with compressed air and blowgun. Any blocked passages must be cleared with a wire or other tool and then blown out.

LEARNING ACTIVITIES:

1. Read pages 2-23 to 2-24, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.
2. Read the directions in the engine technical manual or I&T Shop Manual to find the procedure needed for stripping the cylinder block.
3. Describe the washing procedure that you would use in cleaning the cylinder block, oil passages, and piston.
4. Clean the cylinder block, oil passages, and piston on the designated tractor.

CRITERION EVALUATION: Upon visual inspection all parts of the cylinder block, oil passages, and piston will be clean. There will be no significant damage to any parts.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: De-glaze cylinder

PERFORMANCE OBJECTIVE: Given a cylinder and a cylinder hone, de-glaze a cylinder.

PERFORMANCE GUIDE:

1. With pistons removed, cover the crankshaft with clean cloths (if shaft is still in engine).
2. Adjust cylinder hone (glaze breaker) to fit cylinder and attach to electric drill.
3. Oil hone lightly throughout honing process.
4. Hone should be moved up and down in the cylinder to produce a cross-hatch pattern which helps piston ring break-in. Operate drill at 400 RPM or less.
5. Progress should be checked often to guard against over-honing.
6. When honing is completed, cylinders should be scrubbed clean with hot water and detergent to remove all abrasive particles and then oiled lightly to prevent rust.

LEARNING ACTIVITIES:

1. Read pages 2-28 to 2-29, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Complete the following questions:

   A. What is deglazing?
   B. What is the purpose of deglazing a cylinder?
   C. Describe the appearance of a cylinder wall which needs to be deglazed.
   D. Why should you thoroughly clean the cylinder bores after honing?
   E. Should you use gasoline, kerosene or commerical cleaners to clean cylinder after honing? Why?

3. Deglaze the cylinder on the designated engine. Follow the steps outlined in the Performance Guide.

SUPPLEMENTAL READING: 1. Page 28[illegible], Diesel Fundamentals, Service, Repair, William K. Toboldt, The Goodheart-Willcox Company, Inc., Publishers, 1977.

CRITERION EVALUATION: The honing will remove most glaze (small, isolated spots of glaze are sometimes necessary to prevent over-honing). No abrasive will be allowed to come in contact with the crank shaft.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Grind valves

PERFORMANCE OBJECTIVE: Given a mechanic's tool set, a valve spring compressor, and valve grinding machine, grind the valves.

PERFORMANCE GUIDE:

1. Remove cylinder head.
2. Remove valve springs and keepers, being careful to keep all parts in order so they can be reassembled.
3. Remove valves, keeping them in order.
4. Check valve stems and guides for wear. Replace if necessary.
5. Grind each valve to specified face angle. Check for adequate margin.
6. Using lapping compound and hand-lapping tool, mate each valve to its seat. Then remove all traces of lapping compound.
7. Reinstall valve springs and keepers in their original place.
8. Reinstall head and adjust valves.

LEARNING ACTIVITIES:

1. Read pages 2-13 to 2-14, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Study the section on valves and seats in the I&T Shop Manual for the designated tractor.

3. Answer the following questions:

   A. What is the purpose of valve seating?
   B. Why is valve grinding necessary?
   C. List five precautions for grinding valves.

4. Grind the valves that were removed from the designated engine.

SUPPLEMENTAL READINGS:

1. Pages 438-441, Mechanics in Agriculture, Lloyd J. Phipps, Second Edition, 1977, The Interstate Printers and Publishers, Inc.
2. Pages 376-378, Farm Mechanics Text and Handbook, Phipps, McColly, Scranton, and Cook, 1954, The Interstate Printers and Publishers.
3. Page 275, Diesel Fundamentals, Service, Repair, William K. Toboldt, 1977, The Goodheart-Willcox Company, Inc.
4. Pages D-41-C to D-44-C, Diesel Engine Mechanics, William A. Foutes, Mid-America Vocational Curriculum Consortium, Inc., 1977.

CRITERION EVALUATION: The valves will be ground so they will mate perfectly with their seats. There will be no traces of lapping compound on or around the valves.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Install connecting rods caps

PERFORMANCE OBJECTIVE: Given a mechanic's tool set, service manual, micrometers, plastigage, and a soft-face hammer, install connecting rod caps on the designated tractor.

PERFORMANCE GUIDE:

1. Remove all parts necessary to make piston and crankshaft accessible. Mark parts for proper assembly.
2. Unbolt rod cap.
3. Jar cap loose from rod with a soft-faced hammer.
4. Remove cap, noting its position for reassembly.
5. Push rod away from crankshaft, taking care not to scratch crankshaft journal.
6. Use a micrometer to check the crankshaft journal for excess wear (if piston is to be removed for ring replacement, etc., now is the time).
7. Pry insert from rod and rod cap.
8. Install new inserts in the same piston.
9. Oil bearings lightly with engine oil.
10. Reseat rod on crankshaft journal. Don't scratch crankshaft.
11. Reinstall rod cap.
12. Torque to specifications (to seat inserts).
13. Remove cap and place a strip of "plastigage" across the insert.
14. Replace cap and torque to specifications.
15. Remove cap and measure plastigage width using card that comes with plastigage.
16. If clearance is within specified limits, clean plastigage from insert and journal. Lubricate, install, and torque rod cap.
17. Bend up lock tabs or install lock wires as required.
18. Reassemble engine.

LEARNING ACTIVITIES:

1. Read pages 2-46 to 2-48, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Study carefully the section on connecting rods and caps in either the manufacturer's service manual or the I&T Shop Manual.

3. Install connecting rod caps on the designated tractor. Follow the steps outlined in the Performance Guide.

CRITERION EVALUATION: The bearing will be properly seated as specified in the service manual.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Install a crankshaft

PERFORMANCE OBJECTIVE: Given a mechanic's tool set and plastigage, install a crankshaft on the designated tractor.

PERFORMANCE GUIDE:

1. Remove old crankshaft. Mark parts for proper reassembly.
2. New bearings should be used on a new crankshaft. Replace both main and rod bearings.
3. Install inserts in block for main bearings.
4. Install inserts in main caps.
5. Lubricate inserts with engine oil.
6. Put crank in place and install main caps, being sure caps are on the correct bearings and turned the right way.
7. Torque all main cap bolts.
8. Remove front main cap and place a strip of plastigage across the full width of the insert.
9. Install and torque cap.
10. Remove cap and measure plastigage (at front, center, and back of insert).
11. If clearance is not to specifications, correct it with over- or under-sized insert and check again.
12. When clearance is correct, clean plastigage off insert and journal, and replace and torque cap.
13. Do the same for each additional main bearing.
14. Turn crankshaft a few turns by hand to be sure it does not bind.
15. Install number one piston and rod.
16. Install inserts and rod cap and check clearance as shown previously.
17. Turn crankshaft by hand to check for binding.
18. Follow the same procedure for each additional piston and rod.

LEARNING ACTIVITIES:

1. Read the section on crankshafts in either the I&T Shop Manual or the manufacturer's service manual. Make a note of the torque specifications.

2. Read pages 2-48 to 2-54, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

3. Answer the following questions:

   A. What is a crankshaft?
   B. What are the three main parts of the crankshaft?

C Name six things for which you should check when a crankshaft has been removed for reconditioning.

D. If one of the main journals is defective should the whole crankshaft be replaced? Why?

E. Should the crankshaft have any end play? Why?

F. What will happen if the crankshaft has too much end play? Too little endplay?

4. Draw a basic sketch of a 4-cylinder engine crankshaft and throw arrangement. Do the same for a 6 cylinder engine.

5. In the shop area, install a crankshaft on the assigned tractor engine.

SUPPLEMENTAL READINGS:

1. Pages D-165-C to D-170-C, Diesel Engine Mechanics, William A. Foutes, Mid-America Vocational Curriculum Consortium, Inc., 1977.
2. Pages 184-188, Diesel Fundamentals, Service, Repair, Bill Toboldt, The Goodheart-Willcox Co., Inc., 1977.

CRITERION EVALUATION: All of the following steps will be completed.

1. Installed main bearing inserts.
2. Installed main cap inserts.
3. Torqued and installed main caps.
4. Identified clearance using plastigage.
5. Installed pistons and rods.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Install cylinder heads

PERFORMANCE OBJECTIVE: Given a mechanic's tool set and service manual, install a cylinder head on the designated tractor.

PERFORMANCE GUIDE:

1. With old head removed, block and piston tops cleaned, and valves ground in place, coat mating surface of the block with gasket sealing compound when compound is recommended.
2. Install new head gasket, right side up. (It should be marked as to which side goes toward the head.)
3. Coat top of head gasket with sealing compound if compound is recommended.
4. Lower head in place, being careful not to shift head gasket.
5. Install head bolts hand tight.
6. Install head bolts using a spiral sequence. and tightening in steps of about 10 foot-pounds until specified torque is reached.
7. Reassemble remainder of engine and adjust valves.
8. Re-torque head after a few hours of light duty operation.

LEARNING ACTIVITIES:

1. Read pages 2-4 to 2-5, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Read over the section on replacing cylinder heads in either the I&T Shop Manual or the manufacturer's service manual. Make a note of specified head bolt torque and the tightening sequence.

3. Read pages 49-50, Tractor Maintenance, AAVIM, 1973.

4. Draw a diagram of the sequence used in tightening each of the cylinder head bolts for your designated engine.

5. Install the cylinder head on the designated tractor.

SUPPLEMENTAL READINGS:

1. Page 277, Diesel, Fundamentals, Service, Repair, Bill Toboldt, The Goodheart-Willcox Co., Inc., 1977.

2. Pages C-28-D to C-29-D, Diesel Engine Mechanics, William A. Foutes, Mid-America Vocational Curriculum Consortium, Inc., 1977.

CRITERION EVALUATION: All parts will be installed with no visible leaks and torqued to service manual specifications.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Install front oil seals

PERFORMANCE OBJECTIVE: Given a mechanic's tool set and a seal driver, install front oil seal.

PERFORMANCE GUIDE:

1. After removing other parts as necessary, remove timing gear (or timing chain) cover.
2. Remove old seal from timing cover and clean seal bore.
3. Apply light coat of appropriate sealing compound to outer surface of new seal.
4. Drive seal in place with correct size seal installer, being sure the seal seats fully.
5. Lubricate seal with engine oil.
6. Reinstall timing cover with appropriate gasket, sealer, etc., being very careful not to damage the seal as it fits over end of crankshaft.
7. Torque timing cover bolts to specification.
8. Reinstall other parts removed in step (1) above.

LEARNING ACTIVITIES:

1. Read the section on crankshafts in the I&T Shop Manual or manufacturer's service manual. Make a note of the torque specifications for the timing cover.

2. Install the front oil seal in the designated tractor.

CRITERION EVALUATION: The seal will be fully installed in a clean bore and correctly fitted around crankshaft. All parts will be reinstalled in good order with no leaks present.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Install main bearings and caps

PERFORMANCE OBJECTIVE: Given bearings and caps, a mechanic's tool set, service manual, and engine oil, install main bearings and caps on the designated tractor.

PERFORMANCE GUIDE:

1. Remove crankshaft. Mark all parts for proper reassembly as they are removed.
2. Remove main bearings and rod bearings.
3. Install inserts in block for main bearings.
4. Install new main and rod bearings.
5. Install inserts in main caps.
6. Lubricate inserts with engine oil.
7. Put crank in place and install main caps.
8. Torque all main cap bolts.
9. Remove front main cap and place a strip of plastigage across the full width of insert.
10. Install and torque cap.
11. Remove cap and measure plastigage (at front, center, and back of insert).
12. If clearance is not to specifications, correct it with over- or under-sized insert and check again.
13. When clearance is correct, clean plastigage off insert and journal and replace and torque caps.
14. Do the same for each additional main bearing.
15. Turn crankshaft by hand to make sure it does not bind.
16. Install number one piston and rod.
17. Install inserts and rod cap and check clearance as shown previously.
18. Turn crankshaft by hand to check for binding.
19. Follow the same procedure for each additional piston and rod.

LEARNING ACTIVITIES:

1. Read pages 2-26 to 2-61, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Answer the following questions:

   A. What are 5 things that bearings must do?
   B. List the major causes of bearing failure.
   C. What are three signs that could be analyzed as bearing failure?

3. In the shop area, install main bearings and caps on the designated tractor.

SUPPLEMENTAL READINGS:

1. Pages D-165-C to D-178-C, Diesel Engine Mechanics, William A. Foutes, Mid-America Vocational Curriculum Consortium, Inc., 1977.
2. I&T Shop Manual, Technical Publications, Inc. Kansas City, Mo.

CRITERION EVALUATION: All main cap bolts will be torqued and clearances measured to manufacturer's specifications.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Install piston assembly

PERFORMANCE OBJECTIVE: Given a mechanic's tool set and piston ring compressor, install a piston assembly in the designated tractor.

PERFORMANCE GUIDE:

1. With rings installed on piston and lightly oiled, rod installed in piston, and cylinder honed and cleaned, tighten ring compressor on piston and rings.
2. Place piston in cylinder being sure the correct side faces front and the rod correctly fits on the crankshaft.
3. Tap piston down into cylinder with a block of soft wood or soft-faced hammer, watching to see that the rod seats correctly on the crankshaft.
4. Install bearing inserts and rod caps.

LEARNING ACTIVITIES:

1. Read the section on servicing the piston assembly in either the manufacturer's service manual or the I&T Shop Manual for instructions on how to position the piston in the cylinder.

2. Read page 2-43, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

3. Complete the following questions:

   A. Why must you thoroughly lubricate each piston and its ring with engine oil just prior to installation on the cylinder?
   B. Why should you never pound on the piston head?

4. Install a piston assembly in the designated tractor.

CRITERION EVALUATION: The piston will be installed without any damage to any part of the engine.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Install rear-main oil seals

PERFORMANCE OBJECTIVE: Given a mechanic's tool set, a torque wrench, a new gasket, and a seal, install rear main oil seal.

PERFORMANCE GUIDE:

1. Remove oil pan and clean.
2. Remove all traces of oil pan gasket from block.
3. Remove rear main bearing cap.
4. Loosen other main bearings to allow crankshaft to drop slightly.
5. Pull out old seal.
6. Lubricate top half of new seal and put in place.
7. Coat outside of new seal with sealing compound and put in place in rear main cap. Take care not to get compound on lip of seal.
8. Lubricate lip of seal with engine oil.
9. Put rear main cap (with seal) in place.
10. Torque main bearings to service manual specifications.
11. Reinstall oil pan with new gasket and sealing compound.

LEARNING ACTIVITIES:

1. Read the I&T Shop Manual or the manufacturer's service manual to learn the correct torque specifications for installing the main bearings.

2. Install a rear-main oil seal on the designated tractor.

CRITERION EVALUATION: The new seal will be correctly placed and will hold oil. Other parts will be correctly placed and tightened.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Install rod bearings

PERFORMANCE OBJECTIVE: Given a complete mechanic's tool set, service manual, micrometers, plastigage, and a soft-faced hammer, install rod bearings on the designated tractor.

PERFORMANCE GUIDE:

1. Remove all parts necessary to make piston and crankshaft accessible.
2. Unbolt rod cap.
3. Jar cap loose from rod with a soft-faced hammer.
4. Remove cap noting its position for reassembly. Mark them if not marked.
5. Push rod away from crankshaft taking care not to scratch crankshaft journal.
6. 'Mic" journal for excess wear. (If piston is to be removed for ring replacement etc., now is the time.)
7. Pry insert from rod and rod cap.
8. Remove rod bearings and install new rod bearings.
9. Install new inserts in the same position.
10. Oil bearings lightly with engine oil.
11. Reseat rod on crankshaft journal. Don't scratch crankshaft.
12. Reinstall rod cap.
13. Torque to specifications (to seat inserts).
14. Remove cap and place a strip of "plastigage" across the insert.
15. Replace cap and torque to specifications.
16. Remove cap and measure plastigage width using card that comes with plastigage.
17. If clearance is within specified limits, clean plastigage from insert and journal. Lubricate, install, and torque rod cap.
18. Bend up lock tabs or install lock wires as required.
19. Reassemble engine.

LEARNING ACTIVITIES:

1. Read pages 2-47 to 2-48, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Read the service manual or the I&T Shop Manual for instructions in removing all parts necessary to make the pistons and crankshaft accessible.

3. Make a note of the torque specifications needed for this task.

4. Install the rod bearings on the designated tractor engine. Follow the steps outlined in the Performance Guide.

CRITERION EVALUATION: The rod bearings will be properly seated. All bearings will be torqued and clearance checked as specified in service manual.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Install timing chain or gears

PERFORMANCE OBJECTIVE: Given a timing gear or chain, a mechanic's tool set, service manual, and pullers for the engine being worked on, install the timing gear or chain on the designated tractor.

PERFORMANCE GUIDE:

1. After removing other parts, (depending on type of tractor) remove timing chain or timing gear cover.
2. Crank engine and observe alignment of timing marks.
3. Unbolt camshaft gear (sprocket).
4. Pull gear (sprocket) from camshaft with appropriate puller.
   Note: On timing chain assemblies the camshaft sprocket, chain, and crankshaft should be removed as an assembly.
   Note: Although the camshaft should be keyed so the gear (sprocket) can be installed one way, note position for reassembly.
5. Reassemble and install timing parts with timing marks correctly aligned.
6. Reassemble other parts as necessary.

LEARNING ACTIVITIES:

1. Read page 2-62, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Complete the Student Self-Check I, "Installing the Timing Chain" or Gear.

3. Read the section on timing gears for the designated tractor in either the manufacturer's service manual or the I&T Shop Manual.

4. Install a timing chain or gears on the designated engine. Follow the steps outlined in the Performance Guide.

SUPPLEMENTAL READING:

1. Page 63, Diesel and High Compression Gas Engines, Edgar Kates and William Luck, 3rd Edition, American Technical Society, Chicago, 1974.

CRITERION EVALUATION: All parts will be assembled in correct order and the timing will be to manufacturer's specifications.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Measure bearing clearance

PERFORMANCE OBJECTIVE: Given a mechanic's tool set, micrometers, plastigage, and a soft-faced hammer, measure the bearing clearance.

PERFORMANCE GUIDE:

1. Remove all parts necessary to make pistons, crankshaft, and bearings accessible.
2. Remove cap and place a piece of plastigage across the insert.
3. Replace cap and torque to specifications.
4. Remove cap and measure plastigage width using card that comes with plastigage.
5. If clearance is within specified limits, clean plastigage from insert and journal. Lubricate, install, and torque rod cap.
6. Bend up lock tabs or install lock wires as required.
7. Reassemble engine.

LEARNING ACTIVITIES:

1. Read pages 2-47 to 2-48, Fundamentals of Service-Engines, Deere and Co., Moline, Ill.
2. Measure the bearing clearance with a micrometer.
3. Measure the bearing clearance using plastigage.
4. Compare the two sets of readings to see which method gives the best measurement.

SUPPLEMENTAL READING:

1. Page 285, Diesel Fundamentals, Service, Repair, William Toboldt, The Goodheart-Willcox Company, Inc., 1977.

CRITERION EVALUATION: The measurement will agree with the instructor's measurement.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Measure camshaft for wear

PERFORMANCE OBJECTIVE: Given a complete mechanic's tool set, service manual, and a micrometer, measure the camshaft for wear.

PERFORMANCE GUIDE:

1. Remove camshaft and inspect visually for obvious damage.
2. Using appropriate micrometer, measure each lobe of the cam and record measurement.
3. Compare your measurement with specifications for the camshaft.
4. Reinstall or replace camshaft as necessary.

LEARNING ACTIVITIES:

1. Read pages 2-18 to 2-19, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Read the section on servicing camshafts, for the assigned engine, in either the I&T Shop Manual or the manufacturer's service manual. Note the required specifications for the camshaft of the designated engine.

3. Answer the following questions:

   A. When should you always check the camshaft?
   B. What is the function of a camshaft in the engine?
   C. What should you look for when inspecting the camshaft journals?

4. Measure the camshaft wear on the designated tractor.

SUPPLEMENTAL READINGS:

1. Page 282, Diesel Fundamentals, Service, Repair, William Toboldt, the Goodheart-Willcox Co., Inc. 1977.
2. Page C-107-D to C-107-E, Diesel Engine Mechanics, William A. Foutes, Mid-American Vocational Curriculum Consortium, Inc., 1977.

CRITERION EVALUATION: All variations from the specifications will be determined.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Measure and record crankshaft main and rod journals

PERFORMANCE OBJECTIVE: Given a service manual, micrometer, and a mechanic's tool set, measure and record the crankshaft main and rod journals.

PERFORMANCE GUIDE:

1. With crankshaft removed, clean and visually inspect for obvious damage.
2. Using outside micrometer, make and record three measurements for each bearing journal, one in the middle and one near each end of each journal.
3. Compare your measurements with specifications for the crankshaft.
4. Any significant variation between the three measurements on any one journal indicates uneven wear. Record variations.

LEARNING ACTIVITIES:

1. Read pages 2-50 to 2-51, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Check the measurement specifications in either the I&T Shop Manual or the manufacturer's service manual for bearing journals.

3. Answer the following questions:

   A. What are the wear limits for your engine's crankshaft?
   B. Describe how you could use "plastigage" to measure main bearing clearance.
   C. What causes the ridging on the crankshaft and what will happen if it is not removed before the new bearing is installed?
   D. Describe how you could remove low ridges.

4. Measure and record the crankshaft main and rod journals on the designated tractor.

SUPPLEMENTAL READING: 1. Pages 260-262, Diesel Fundamentals, Service, Repair, William Toboldt, The Goodheart-Willcox Company, Inc., 1977.

CRITERION EVALUATION: Recorded measurements will be the same as those of the instructor.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Measure cylinder taper

PERFORMANCE OBJECTIVE: Given a cylinder and a feeler gauge, measure the cylinder taper.

PERFORMANCE GUIDE:

1. With piston removed, carefully compress a ring and insert it in the cylinder.
2. Be sure the ring is lined up in the cylinder by tapping it down about one inch with the top of an inverted piston.
3. Measure the gap between the ends of the ring with a feeler gauge and record reading. (Cylinder bore gauge or telescoping micrometer may be used.)
4. Take readings at one inch intervals down to the lowest point of ring travel.
5. The difference between the largest and smallest readings divided by 3.1416 gives the cylinder taper.

LEARNING ACTIVITIES:

1. Read pages 2-26 to 2-27, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Read the section on cylinders in either the I&T Shop Manual or the manufacturer's service manual.

3. Complete the following questions:

   A. Describe another method for measuring cylinder for taper and out of roundness other than the one given in the Performance Guide.
   B. Generally, when is a cylinder in need of reboring?
   C. What are the manufacturer's rules for exact wear limits?
   D. Why should you normally replace the piston when the cylinder is replaced or reconditioned?

4. In the shop area, measure a cylinder taper on the designated engine.

SUPPLEMENTAL READING:

1. Page D-130-C, Diesel Engine Mechanics, William A. Foutes, Mid-America Vocational Curriculum Consortium, Inc., 1977.

CRITERION EVALUATION: The readings and computations will agree with those of the instructor.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Measure piston-ring end gap

PERFORMANCE OBJECTIVE: Given a piston ring and feeler gauge, measure the piston-ring end gap.

PERFORMANCE GUIDE:

1. With piston removed, carefully compress a ring and insert it in the cylinder.
2. Be sure the ring is lined up in the cylinder by tapping it down about one inch with the top of an inverted piston.
3. Measure the gap between the ends of the ring with a feeler gauge, and record reading.
4. Take readings at one inch intervals down to the lowest point of ring travel. The smallest reading is the ring end gap.

LEARNING ACTIVITIES:

1. Study the section on servicing the piston assembly in either the I&T Shop Manual or the manufacturer's service manual for the assigned tractor engine.
2. Find the correct piston-ring end gap specification.
3. Watch another student as he or she correctly performs and is checked out on this competency.
4. In the shop area, with the help of the steps outlined in the Performance Guide, measure a piston-ring end gap in a laboratory setting.

CRITERION EVALUATION: Measurement will agree with that of instructor.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Measure piston-ring land clearance

PERFORMANCE OBJECTIVE: Given a piston ring and feeler gauge, measure the piston-ring land clearance on the designated tractor.

PERFORMANCE GUIDE:

1. With piston cleaned and carbon removed, place the edge of the ring in the groove in which the ring will run.
2. Hold feeler gauge in groove beside the ring. Measure clearance between the ring and the side of the groove.
3. Rotate piston and check measurement around total circumference. Record measurement.

LEARNING ACTIVITIES:

1. Read pages 2-41 to 2-42, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Consult the I&T Shop Manual or the manufacturer's service manual for the correct piston-ring line clearance.

3. On the assigned engine, measure the piston ring-land clearance and record the results. Follow the steps outlined in the Performance Guide.

SUPPLEMENTAL READING:

1. Page D-75-C, Diesel Engine Mechanics, William A. Foutes, Mid-America Vocational Curriculum Consortium, Inc., 1977.

CRITERION EVALUATION: The recorded measurements will be the same as that of the instructor.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Measure valve-stem guide clearance

PERFORMANCE OBJECTIVE: Given a mechanic's tool set and a dial indicator, measure the valve-stem guide clearance.

PERFORMANCE GUIDE:

1. Develop skill in reading dial indicator.
2. With head removed and valve springs and keepers taken off, connect dial indicator to head with the pickup against the valve stem.
3. With the valve off its seat measure the lateral movement of the valve stem. This is "guide clearance." (The stem and guide must be clean and dry to get an accurate measurement.) Record measurement.

LEARNING ACTIVITIES:

1. Read pages 2-14 to 2-15, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Read the section on valve maintenance in either the manufacturer's service manual or the I&T Shop Manual.

3. Answer the following questions:

   A. Why shouldn't you use plugs, valve stems, or pilots to measure valve guides?
   B. Describe a method for measuring valve-stem guide clearance, other than the method given in the Performance Guide.
   C. What are the manufacturer's rules for the exact wear limits?

4. With the help of the Performance Guide, measure a valve stem guide clearance.

SUPPLEMENTAL READING:

1. Page D-40-C, Diesel Engine Mechanics, William A. Foutes, Mid-America Vocational Curriculum Consortium, Inc., 1977.

CRITERION EVALUATION: The recorded measurement will be the same as the instructor's measurements.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Reface valve seats

PERFORMANCE OBJECTIVE: Given a mechanic's tool set, a valve grinding machine, lapping compound, and a tool and valve-seat refacing set, reface the valve seats.

PERFORMANCE GUIDE:

1. Remove cylinder head.
2. Remove valve springs and keepers using a valve spring compressor. Keep them in order for reinstallation.
3. Check valves, stem, and guides for wear. Replace as necessary.
4. Remove valves, keeping them in order.
5. Grind valves to specified face angle if necessary.
6. Select proper pilot to fit valve guide.
7. Dress refacing stone to specified angle.
8. Reface valve seats, redressing stone as necessary. Take off only enough to get a smooth seat.
9. Narrow seats if necessary, using proper stone to cut off upper surface of face.
10. Using lapping compound and a hand-lapping tool, mate each valve to its seat. Remove all traces of lapping compound.
11. Reinstall valves, springs, and keepers in their original places.
12. Reinstall head and adjust valves.

LEARNING ACTIVITIES:

1. Read pages 2-13 to 2-14, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Study the section on valve assembly in the manufacturer's service manual or the I&T Shop Manual.

3. Answer the following questions:

   A. Describe a good method to prevent cutting valve seats too wide.
   B. Wide seats improve _____ _____, while narrow seats give better _____ of valve.
   C. What should be done to the valve seat to cause a better seating force? What are the good and bad points that will result from this?
   D. When grinding valve seats, how much of the valve face should be exposed to the combustion chamber?
   E. List five precautions for grinding valve seats.
   F. What are three things that will assure a good valve seat?
   G. What are the manufacturer's specifications for the valve seat runout (eccentricity)?

4. Reface the valve seats on the designated tractor.

SUPPLEMENTAL READINGS:

1. Pages 438-440, Mechanics in Agriculture, Lloyd J. Phipps, Second Edition, The Interstate Printers and Publishers, Inc., Danville, Ill., 1977.
2. Pages 376-378, Farm Mechanics Text and Handbook, Phipps McColly, Scranton, Cook, The Interstate Printers and Publishers, Danville, Ill., 1954.
3. Pages 375-376, Diesel Fundamentals, Services, Repairs, Bill Toboldt, The Goodheart-Willcox Co., Inc., 1977.

CRITERION EVALUATION: The valve seats will mate perfectly with the valves and all lapping compound will be removed upon completion.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Remove carbon from ring grooves

PERFORMANCE OBJECTIVE: Given a mechanic's tool set, a ring-groove cleaner, or an old ring and ring expander, remove the carbon from the ring grooves.

PERFORMANCE GUIDE:

1. Remove piston from engine.
2. Remove rings from piston.
3. Select proper cutter on ring groove cleaning tool and place tool on piston. Turn tool around piston to clean groove.
4. If groove cleaning tool with correct cutter is not available, a piece of an old ring makes a fair substitute.
5. Be careful not to remove any metal from the piston. Removal of any metal will affect ring side clearance.

LEARNING ACTIVITIES:

1. Read page 2-39, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.
2. Read the section on servicing the piston assembly in either the I&T Shop Manual or the manufacturer's service manual.
3. In the shop area, remove the carbon from the piston ring grooves. Follow the steps outlined in the Performance Guide.

SUPPLEMENTAL READINGS:

1. Pages 288-289, Diesel Fundamentals, Service, Repair, William K. Toboldt, The Goodheart-Willcox Co., Inc., South Holland, Ill., 1977.
2. Page 379, Farm Mechanics Text and Handbook, Phipps, McColly, Scranton and Cook, The Interstate Printers and Publishers, Danville, Ill., 1954.
3. Page 442, Mechanics in Agriculture, Lloyd Phipps, The Interstate Printers and Publishers, Inc., Danville, Ill., 1977.

CRITERION EVALUATION: The piston will be clean. No metal will be shaved from the piston.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Remove cylinder ridge

PERFORMANCE OBJECTIVE: Given a mechanic's tool set and a ridge reamer, remove a cylinder ridge from the piston cylinder.

PERFORMANCE GUIDE:

1. With cylinder head removed, crank engine to place piston at bottom of stroke.
2. Install ridge reamer in top of cylinder. (An oily rag placed on top of cylinder will catch metal and carbon shavings.)
3. Turn ridge reamer with a ratchet. (Turn it only in the direction in which it cuts. Turning backward will damage the cutter.)
4. Keep enough tension on cutter to cut a small shaving, but not enough to cause it to "dig in."
5. Ream slowly and inspect the ridge often. Stop as soon as the ridge is cut sufficiently to allow the piston to be removed. (Any remaining ridge will be removed when the cylinder is honed.)
6. Clean out cylinder carefully before moving piston.

LEARNING ACTIVITIES:

1. Read pages 2-26 to 2-27, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Read the steps for removing the cylinder head and for servicing the cylinders outlined in either the manufacturer's service manual or the I&T Shop Manual.

3. Watch another student as he or she satisfactorily completes this competency.

4. In a clean area of the shop, remove a cylinder ridge from the piston sylinder.

CRITERION EVALUATION: The ridge will be cut enough to allow piston to be removed, but not deeper than the ring wear mark. The cylinder will be free of all metal shavings.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Remove piston assembly

PERFORMANCE OBJECTIVE: Given a mechanic's tool set and a soft-faced hammer, remove a piston assembly from the designated tractor.

PERFORMANCE GUIDE:

1. With head and oil pan removed and cylinder reamed, loosen rod cap bolts or nuts.
2. Check piston and rod for identifying marks. If they are not already marked, mark each piston, rod, and rod cap with cylinder number and direction of placement.
3. Tap rod cap loose with a soft-faced hammer if necessary.
4. Remove rod cap bolts (or nuts) and push piston out of cylinder.

LEARNING ACTIVITIES:

1. Read the section on servicing the piston assembly in either the manufacturer's service manual or the I&T Shop Manual.

2. Watch another student as he or she satisfactorily removes the piston assembly.

3. Read pages 2-30 to 2-43, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

4. Complete the Self-Test, "Servicing the Piston Assembly" provided by the instructor.

5. Remove the piston assembly from the designated engine.

CRITERION EVALUATION: The piston will be removed without damage to the piston or any other part of the engine.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Replace camshaft bearings

PERFORMANCE OBJECTIVE: Given the designated tractor, a new set of camshaft bearings, the service manual for the tractor, a micrometer for measuring parts to specifications and the necessary tools and lubricants, replace the camshaft bearings.

PERFORMANCE GUIDE:

1. Follow instructions in the manufacturer's service manual to remove all parts necessary to reach camshaft bearings.
2. Read service manual to ascertain which bearings are the proper ones for the tractor being repaired. NOTE: Bearings must match the camshaft. Some manufacturers have undersized bearings for replacement parts as well as special installation tools.
3. Line up the oil holes prior to and after assembly. Check the registry of these holes with those in the cylinder block with a wire.
4. Reassemble according to manufacturer's instructions and specifications, checking the camfollowers, camlobes, and camshafts for damage or wear and adjusting to specifications outlined in the service manual.
5. Reassemble all other parts removed.

LEARNING ACTIVITIES:

1. Read the section on servicing the camshaft in the I&T Shop Manual or the manufacturer's service manual. Pay special attention to the recommended replacement bearings.

2. Read page 2-19, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

3. Complete the following questions:

   A. What bearings are the proper ones for the tractor you are repairing?
   B. How can you make certain the camshaft bearing will be lubricated after assembly?
   C. What are the torque specifications that you will need to know when reassembling the engine?

4. Replace the camshaft bearing on the designated tractor. Follow the steps given in the Performance Guide and the service manual.

SUPPLEMENTAL READING: 1. Pages 281-282, Diesel Fundamentals, Service, Repair, William Toboldt, The Goodheart-Willcox Company, Inc., South Holland, Ill., 1973.

CRITERION EVALUATION: Disassembly and reassembly will be in the order recommended in the service manual and the new bearings will be the same size as those replaced. All parts will be to manufacturer's specifications and there will be no damage to any parts.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Replace dry sleeves

PERFORMANCE OBJECTIVE: Given a mechanic's tool set and a sleeve puller, replace dry sleeves.

PERFORMANCE GUIDE:

1. Remove grease or cosmoline from new sleeve. "Mic" to insure proper size.
2. Put new sleeves in freezer. (This shrinks them for easier installation.)
3. With cylinder head and pistons removed, put sleeve puller in place over one cylinder.
4. Make sure puller disc bears only on the sleeve and does not contact cylinder block.
5. Turn puller only with hand tools and remove old sleeve. (Do not use an impact wrench.)
6. Remove other sleeves the same way.
7. Clean out cylinder holes in block.
8. Remove new sleeves from freezer and insert them quickly into their places. If they do not seat freely, they must be tapped into place quickly with a soft-faced hammer before they warm up and swell into the block.

LEARNING ACTIVITIES:

1. Read pages 2-26 to 2-29, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Read the section on cylinders in the manufacturer's service manual or the I&T Shop Manual.

3. Answer the following questions after reading the above assignments;

   A. Before installing dry-type cylinder sleeves why must you always inspect the cylinder bores?
   B. If the bores are distorted what should you do? Why?
   C. Describe how you would clean carbon and gum deposits from the cylinder bores.
   D. List the recommendations the manufacturer gives for installing new sleeves.

4. In the shop area, replace the dry sleeves on the designated tractor engine.

SUPPLEMENTAL READINGS:

1. Pages 166-167, Diesel Fundamentals, Service, Repair, William Toboldt, The Goodheart-Willcox Company, Inc., South Holland, Ill., 1973.

2. Page D-131-C, Diesel Engine Mechanics, William A. Foutes, Mid-America Vocational Curriculum Consortium, Inc., 1977.

CRITERION EVALUATION: The old sleeves will be removed without damage to the block; the block will be thoroughly cleaned and the new sleeves will be fully seated.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Replace oil pan gasket assembly

PERFORMANCE OBJECTIVE: Given a mechanic's tool set and a torque wrench, gasket and gasket compound, replace the oil pan and gasket assembly.

PERFORMANCE GUIDE:

1. Drain engine oil.
2. Remove oil pan.
3. Clean oil, sludge, dirt, and old gasket from oil pan.
4. Clean all traces of old oil pan gasket from engine block.
5. Coat bottom side of gasket with gasket compound and install on oil pan.
6. Coat top of gasket with gasket compound.
7. Carefully lift pan and gasket into place on engine and run bolts up hand tight. Refer to technical manual for torque specifications.
8. Torque bolts in 5 ft. lb. increments until specified torque is reached.

LEARNING ACTIVITIES:

1. Read the section on replacing the oil pan in the manufacturer's service manual. Note the torque of the oil pan belts.

2. In the shop area, replace the oil pan gasket assembly on the designated tractor. Follow the outlined steps in the Performance Guide.

CRITERION EVALUATION: The oil pan will be clean, the gasket will be in place and sealed and the bolts will be tightened to the correct torque.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Replace piston rings

PERFORMANCE OBJECTIVE: Given new piston rings, a mechanic's tool set, a ring expander, a ridge reamer, a ring compressor, and a groove cleaner, replace old piston rings.

PERFORMANCE GUIDE:

1. Remove the head.
2. Remove the oil pan.
3. Ream the ridge.
4. Remove piston.
5. Remove old rings.
6. Clean piston.
7. Using a ring expander, install new rings being careful not to scratch the piston. Place rings on piston as shown in the instructions that come with the rings. Note the end gap arrangement.
8. Install piston.

LEARNING ACTIVITIES:

1. Read pages 2-31 to 2-39, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Read pages 56-57, Fundamentals of Service-Bearings and Seals, Deere and Co., Moline, Ill., 1974.

3. Answer the following questions:

   A. What are three jobs that piston rings do?
   B. List six conditions that may lead to stuck or plugged rings.
   C. What will cause top groove failure?
   D. Define the following and give their cause,
      (1) abrasive wear
      (2) scuffing and scoring
   D. Can you reinstall piston rings once they have been removed? Why?

4. Read the section on piston rings in either the I&T Shop Manual or the manufacturer's service manual.

5. Replace the piston rings on the designated tractor.

SUPPLEMENTAL READINGS:

1. Pages 441-443, Mechanics in Agriculture, Lloyd J. Phipps, The Interstate Printers and Publishers, 1977.
2. Pages 379-380, Farm Mechanics Text and Handbook, Phipps, McColly, Scranton, and Cook, The Interstate Printers and Publishers, 1954.

3. Pages 175-177, Diesel Fundamentals, Services, Repair, William Toboldt, The Goodheart-Willcox Co., Inc., South Holland, Ill., 1973.

CRITERION EVALUATION: The piston must be clean and unscratched. The following steps must be completed during the replacement process:

1. Head removed
2. Oil pan removed
3. Ridge reamed
4. Piston removed
5. Rings removed
6. Piston cleaned
7. Rings installed

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Replace rear engine oil seal

PERFORMANCE OBJECTIVE: Given a mechanic's tool set, a torque wrench, a new gasket and a seal, install rear engine oil seal.

PERFORMANCE GUIDE:

1. Remove and clean oil pan.
2. Remove all traces of oil pan gasket from block.
3. Remove rear main bearing cap.
4. Loosen other main bearings to allow crankshaft to drop slightly.
5. Pull out old seal.
6. Lubricate top half of new seal and put in place.
7. Coat outside of new seal with sealing compound and put in place in rear main cap.
8. Lubricate lip of seal with engine oil.
9. Put rear main cap (with seal) in place.
10. Torque main bearings.
11. Reinstall oil pan with new gasket and sealing compound.

LEARNING ACTIVITIES:

1. Read the section on crankshafts in either the I&T Shop Manual or the manufacturer's service manual. Note the torque specifications for the main bearings.

2. Watch another student as he or she satisfactorily replaces the rear engine oil seal.

3. In the shop area, install a rear engine oil seal on the designated tractor. Follow the steps outlined in the Performance Guide.

CRITERION EVALUATION: The new seal will be correctly placed and will hold oil. All parts will be correctly placed and tightened.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Replace rocker arms

PERFORMANCE OBJECTIVE: Given new rocker arms, a mechanic's tool set, service manual, outside micrometers and telescoping gauges, replace the rocker arms on the designated tractor.

PERFORMANCE GUIDE:

1. Remove valve cover.
2. Remove rocker arm assembly.
3. Remove lock pin and slide rocker shaft out of rocker assembly, keeping other parts in order.
4. Inspect parts for wear. Use micrometer.
5. Reassemble on an old shaft if it is usable, or on a new shaft if necessary. Use the old parts that are usable and replace those that show excessive wear.
6. Replace assembly and adjust valves.
7. Replace valve cover.

LEARNING ACTIVITIES:

1. Read the section on replacing rocker arms in the manufacturer's service manual or the I&T Shop Manual.

2. Read pages 2-21 to 2-22, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

3. Complete the following questions:

   A. What is a rocker arm and what is its function?
   B. What should you look for when inspecting the following rocker arm components?
      (1) rocker arm shaft
      (2) rocker arms
      (3) spacer springs
   C. When should you replace or recondition rocker arms?
   D. Why is it important to clean the holes in the rocker arm mounting brackets?
   E. When installing rocker arms why must you always install the arms and springs in the same sequence?

4. Watch another student as he or she replaces the rocker arms.

5. Replace the rocker arms on the designated tractor. Follow the steps outlined in the Performance Guide.

SUPPLEMENTAL READING:

1. Pages 181-182, Diesel Fundamentals, Service, Repair, Bill Toboldt, The Goodheart-Willcox Co., Inc., South Holland, Ill., 1977.

CRITERION EVALUATION: Valves will be adjusted to specifications. All the following steps will have been completed and be acceptable to the instructor.

1. Removed valve cover
2. Removed rocker arm assembly
3. Inspected parts
4. Installed new parts
5. Adjusted valves
6. Replaced valve cover

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Replace valve guides

PERFORMANCE OBJECTIVE: Given new valve guides, a dial indicator, arbor press, and/or valve guide puller-driver, replace valve guides on the designated tractor.

PERFORMANCE GUIDE:

1. Measure valve stem clearance and determine which guides need to be replaced.
2. Press out bad guides with an arbor press or pull out with an appropriate puller.
3. Drive out or press new guides in place, being sure they are installed to the correct depth as specified in the service manual. NOTE: Some valve guides are integral with the cylinder head and cannot be replaced. If excessively worn, they must be reamed to take an oversize valve stem and fitted with the appropriate replacement valve.

LEARNING ACTIVITIES:

1. Read pages 2-14 to 2-19, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1977.

2. Read the section on valve guides in either the I&T Shop Manual or the manufacturer's service manual.

3. Complete the following questions:

   A. When should you replace valve guides?
   B. Never grasp the valve guides when turning or handling the cylinder head as you may _____ or _____ the guides.
   C. When replacing new valve guides, what must you do if they compress slightly when installed?
   D. What are the specifications that must be met if you are to "precision ream" a valve guide?

4. Replace the valve guides on the designated tractor. Follow the steps in the Performance Guide.

SUPPLEMENTAL READINGS:

1. Page 274, Diesel Fundamentals, Service, Repair, William Toboldt, The Goodheart-Willcox Co., Inc., South Holland, Ill., 1977.
2. Page D-40-C, Diesel Engine Mechanics, William A. Foutes, Mid-America Vocational Curriculum Consortium, Inc., 1977.

CRITERION EVALUATION: All guides needing service will be detected. Old guides will be removed without damage to the head and new guides will be installed to specified position.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Replace wet sleeves

PERFORMANCE OBJECTIVE: Given new sleeves, service manual lubricants, seals, the necessary tools and checking equipment, replace the wet sleeves on a designated engine.

PERFORMANCE GUIDE: NOTE: In the individually cast cylinder the casting may be called a "liner" or a "sleeve". They may be dry liners or wet liners.

1. Read manufacturer's service manual for instructions for removing all parts necessary to reach the cylinder sleeve. Details of removal will vary with size and type of engine.
2. Use screw-threaded or impact pullers to remove sleeve. (In stubborn cases other aids must be used. It may be necessary to use inhibited acid compounds to remove scales from the water jacket and free the sleeve. Penetrating oil, solvents, or heat may help.)
3. With sleeve removed, clean the lower sealing ring surface in the block to prevent coolant leakage past the sealing rings.
4. Measure the cylinder bore for taper and out-of-roundness. Rebore and hone if necessary. Clean thoroughly.
5. Clean all deposits from under the flange of sleeve and mating bore in block. (Sleeve must rest flat to prevent distortion.)
6. Check sleeve bore in block. If flange surface is uneven, remachine it.
7. Clean the lower sealing surfaces in block and sleeve to prevent coolant leaks when sleeve is installed.
8. Install new sleeve <u>without</u> seals and check height at several places to be certain sleeve is seated squarely. Compare the height to engine specifications and machine the block or add shims if necessary.
9. Remove sleeve and put new seals on sleeve. Lubricate the seal and the mating surfaces in the block with material recommended by manufacturer.
10. Work sleeve into place (by hand) as far as possible. Finish seating the sleeve by placing a wood block over it and hammer gently.
11. Check for correct liner installation by measuring the out-of-roundness in the liner bore. If distorted, check for twisted seals or deposits on the liner bore seats.

12. Following instructions in the service manual, reassemble all parts.

LEARNING ACTIVITIES:

1. Read pages 2-25 to 2-30, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Read the section on cylinders in either the I&T Shop Manual or the manufacturer's service manual.

3. Answer the following questions:

   A. What is the difference between a wet cylinder sleeve and a dry cylinder sleeve?
   B. When installing new wet liners in sleeves why must they lie flat?
   C. Describe a good method used to prevent coolant leaks when a new liner is installed.
   D. Explain how to check for correct liner installation.

4. Replace the wet sleeves of the assigned engine.

SUPPLEMENTAL READINGS:

1. Pages D-129-C to D-131-C, Diesel Engine Mechanics, William A. Foutes, Mid-America Vocational Curriculum Consortium, Inc., 1977.
2. Pages 166-168, Diesel Fundamentals, Service, Repair, William Toboldt, The Goodheart-Willcox Co., Inc., 1977.

CRITERION EVALUATION: Disassembly and reassembly will follow manufacturer's instructions. The out-of-roundness will be within manufacturer's specifications, the cylinder will not leak, and there will be no damage to any parts.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Service intake manifold

PERFORMANCE OBJECTIVE: Given a mechanic's tool set and service manual, service the intake manifold on the designated tractor.

PERFORMANCE GUIDE:

1. Remove carburetor.
2. Remove intake manifold. (This usually requires removal of the exhaust manifold too because they are made together.) (NOTE: Use penetrating oil on nuts, if necessary.)
3. Clean manifold inside and out. Check for warpage.
4. Clean all old gasket material from mating surfaces of manifold and engine.
5. Determine torque specifications from manual.
6. Reinstall manifold with new gaskets, tighten to specified torque.
7. Reinstall carburetor with new gasket.

LEARNING ACTIVITIES:

1. Read pages 6-10 to 6-12, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Read page 16, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

3. Read the section in the manufacturer's service manual on servicing an intake manifold. (Note torque specifications).

4. Complete the Student Self-Check Sheet, "Servicing the Intake Manifold."

5. Service an intake manifold on the designated engine.

SUPPLEMENTAL READINGS:

1. Page D-105-D, Diesel Engine Mechanics, William A. Foutes, Mid-American Vocational Curriculum Consortium, Inc., 1977.
2. Pages 234-236, Diesel and High Compression Gas Engines, Kates and Luck, Third Edition, American Technical Society, 1975.

CRITERION EVALUATION: The manifold will be clean, correctly installed, and torqued.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Test valve springs

PERFORMANCE OBJECTIVE: Given a mechanic's tool set, a service manual, a valve spring compressor, and a valve spring tester, test the valve springs on the designated tractor.

PERFORMANCE GUIDE:

1. Remove valve cover, head and rocker assembly.
2. Remove valves and springs--keep in order for reassembly into the same place.
3. Using valve spring tester and torque wrench, test each spring returning the tested spring to its proper place.
4. Replace faulty springs.
5. Reassemble engine and adjust valves.

LEARNING ACTIVITIES:

1. Read page 2-21, Fundamentals of Service Engines, Deere and Co., Moline, Ill., 1972.

2. Read the section on servicing valves in the I&T Shop Manual or the manufacturer's service manual.

3. Answer the following questions:

   A. What is the main function of the valve spring?
   B. What are six things to look for when inspecting valve springs?
   C. How much tension loss can a valve spring have before it must be replaced?
   D. What is the valve spring tension specification for your tractor's engine?

4. Observe another student as he or she satisfactorily tests the valve springs.

5. Test the valve springs on the assigned tractor. Follow the steps outlined in the Performance Guide.

SUPPLEMENTAL READING:

1. Pages D-37-C to D-38-C, Diesel Engine Mechanics, William A. Foutes, Mid-America Vocational Curriculum Consortium, 1977.

CRITERION EVALUATION: All defective springs will be replaced and the engine will be reassembled. All springs will indicate strength as specified by manufacturer.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING BASIC ENGINE

COMPETENCY: Torque main bearings

PERFORMANCE OBJECTIVE: Given the designated tractor and service manual and a mechanic's tool set, torque the main bearings on the tractor.

PERFORMANCE GUIDE:

1. Determine torque specifications from service manual.
2. With crankshaft installed and all main bearings and bearing caps in place, tighten both bolts of each bearing in sequence by five foot pound increments until all bearings are to specified torque.

LEARNING ACTIVITIES:

1. Read page 2-54, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.
2. Read the section on main bearings in either the manufacturer's service manual or the I&T Shop Manual. Note torque specifications.
3. On the assigned tractor, torque the main bearings.

SUPPLEMENTAL READINGS:

1. Pages 283-284, Diesel Fundamentals, Service, Repair, Bill Toboldt, The Goodheart-Willcox Co., Inc., 1977.
2. Pages D-165-C to D-178-C, Diesel Engine Mechanics, William A. Foutes, Mid-America Vocational Curriculum Consortium, 1977.

CRITERION EVALUATION: All main bearings will be within torque specifications.

SECTION XI Maintaining and Servicing Lubrication System

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STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING LUBRICATION SYSTEM

COMPETENCY: Change the oil filter.

PERFORMANCE OBJECTIVE: Given the manufacturer service manual and the necessary tools, change the oil filter.

PERFORMANCE GUIDE:

1. Operate engine until normal operating temperature is reached. Stop engine and disconnect coil to distributor wire.
2. Locate and clean around drain plug and then remove.
3. Allow crankcase to drain for about 5 minutes.
4. Locate and replace oil filter with same type.
5. Replace drain plug and refill crankcase with new oil of the type recommended in the service manual.
6. Connect coil to distributor wire and start engine. Operate until warm and check for oil leaks. Stop engine and recheck oil level, adding more if needed.

LEARNING ACTIVITIES:

1. Read Chapter 11, pages 32-36 Tractor Maintenance, AAVIM 1975, and complete the following:
   A. Why is it important to change the oil filter?
   B. List the functions of an oil filter?
   C. List three types of oil filter assemblies.
   D. List steps used in order to replace an oil filter in your tractor.

2. If you need additional information on oil filters or filtration system read pages 5-4 to 5-8 Fundamentals of Service-Engines, Deere and co., Moline, Ill., 1972. If instructor directs, complete the following questions.
   A. What should be used to clean edge-type metal oil filters?
   B. What causes leaks after oil filter is installed?
   C. How can you be sure that the oil you are using is of high quality and one that's right for the job?

3. Obtain the correct replacement oil and oil filter, change the oil filter. Use the performance guide to help you. Refer to the service manual whenever needed.

SUPPLEMENTAL READINGS:

1. Chapter 6 of Farm Tractor Tune-Up Service Specifications, AAVIM, 1972.

2. Pages 60-62 of Fundamentals of Operations - Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

3. Pages 232-234 of Diesel Fundamentals, Service Repair. Bill Toblodt Goodheart-Wilcox Publ. 1977.

CRITERION EVALUATION: When finished, the filter will be the one specified. There will be no oil leaks, and the oil level on the dipstick will show "full".

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING LUBRICATION SYSTEM

COMPETENCY: Change tractor oil.

PERFORMANCE OBJECTIVE: Given a wrench for the drain plug, new oil of the type and grade recommended in the operator's manual, clean rags, and a container for the old oil, change the tractor oil.

PERFORMANCE GUIDE:

1. Operate engine until normal operating temperature is reached.
2. Remove drain plug and gasket (if there is one) and clean same.
3. Drain oil into a container. (Change oil filter at this point if needed.)
4. Flush crankcase, according to directions given in the operator's manual.
5. Replace drain plug and tighten same.
6. Locate fill plug.
7. Clean top of new oil can and fill crankcase with new oil specified as to amount and type in operator's manual.
8. Start engine and operate in low gear for a few minutes. Check level with dipstick. Add oil to "full" line.
9. Check pressure gauge and check for oil leaks.
10. Store used oil in closed container.

LEARNING ACTIVITIES:

1. Read pages 29-32, Tractor Maintenance, AAVIM and answer the following questions.
   A. Why are oil changes important?
   B. True or False? "Oil doesn't 'wear out.'" Why?
   C. List 10 steps you would follow when changing the oil in a tractor. Give reasons for each step.

2. If you had difficulty in completing the above activity, or if so directed by the instructor, read Chapter 4, Fundamentals of Machine Operation - Preventive Maintenance, Deere and Co., Moline, Ill., 1973.
   A. Answer questions 1, 3, 5, 8 and 9, at the end of Chapter 4.
   B. How often should you change the oil in a tractor?

3. Change the oil in a tractor with the help of the performance guide.

SUPPLEMENTAL READINGS:

1. Pages 7-18 to 7-19, Fundamentals of Service-Engines, Deere & Co., Moline, Ill., 1972.
2. Pages 35 and 36, Tractor Engine Tune-Up, University of West Virginia, 1973.

CRITERION EVALUATION: When completed, the dipstick will show the oil is at (but not exceeding) the "full" mark and there will be no leaks.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING LUBRICATION SYSTEM

COMPETENCY: Check engine crankcase oil level.

PERFORMANCE OBJECTIVE: Given a clean cloth and oil, check the engine crankcase oil level.

PERFORMANCE GUIDE:

1. Turn off the engine if in operation. (Tractor should be level.)
2. Locate dipstick on left or right side of engine depending on make of tractor.
3. Pull out dipstick and wipe dry with clean cloth.
4. Reinsert dipstick and seat fully.
5. Pull out dipstick and take reading.
6. Replace dipstick.

LEARNING ACTIVITIES:

1. Read page 65, Fundamentals of Machine Operation Preventive Maintenance, Deere and Co., 1973 and answer the following questions.
   A. How often should the crankcase oil be checked?
   B. How long should you wait before checking the oil level after the engine has been operating?
   C. When should you add oil? What type should you add?
   D. What will happen if you overfill the crankcase?

2. Read pages 7 and 8, Tractor Operation and Daily Care, AAVIM, 1970.

3. Check the engine crankcase oil level on the designated tractor with the help of the performance guide.

SUPPLEMENTAL READINGS:

1. Pages 29-31, Tractor Maintenance, AAVIM 1975.
2. Pages 267-268, Fundamentals of Machine Operation-Tractors.

CRITERION EVALUATION: Upon completion the dipstick reading must agree with that of the instructor.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING LUBRICATION SYSTEM

COMPETENCY: Check transmission and/or differential lubricant levels.

PERFORMANCE OBJECTIVE: Given a shop rag, check the transmission and/or differential lubricant level on a tractor equipped with a dip stick.

PERFORMANCE GUIDE:

1. With dip stick:
   a. Pull out dip stick.
   b. Wipe with a clean rag.
   c. Reinsert dip stick and seat fully.
   d. Pull out dip stick and take reading.
   e. Replace dip stick.

LEARNING ACTIVITIES:

1. Read pages 137-139, Fundamentals of Machine Operation Preventive Maintenance. Deere and Co., Moline, Ill., 1973.

2. Read page 88, Tractor Maintenance, AAVIM 1975.

3. Complete the following questions.
   A. How often should you check the transmission and/or differential lubricant levels?
   B. Should the engine be running when you check the lubricant levels?

4. Consult the Farm Tractor Tune-up and Service Guide, AAVIM 1972, for information regarding gear oil type and viscosity.

5. Check the transmission and/or differential lubricant on a designated engine equipped with a dip stick.

CRITERION EVALUATION: The dip stick should be clean when inserted and the student's reading should be the same as the instructor's.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING LUBRICATION SYSTEM

COMPETENCY: Drain and refill differentials

PERFORMANCE OBJECTIVE: Given a container for used oil, plug wrenches, service manual, lubricant, and shop rags, drain and fill the differentials.

PERFORMANCE GUIDE:

1. Remove fill plug.
2. Remove drain plug.
3. Drain out lubricant (use caution to keep lubricant away from shoes and tires).
4. When completely drained, replace drain plug.
5. Fill to the correct level with recommended lubricant.
6. Reinsert fill plug.
7. Dispose of used lubricant.

LEARNING ACTIVITIES:

1. Read pages 137-140, Fundamentals of Machine Operation, Deere and Co., Moline, Ill., 1973 and answer the following questions.
   A. How often should you drain and refill a tractor differential?
   B. Why should you drive the machine first before removing the oil?

2. Consult the operator's manual or Farm Tractor Tune-Up and Service Specifications, AAVIM for the recommended lubricant.

3. Drain and refill the differentials on the designated tractor.

SUPPLEMENTAL READING: Pages 136-137, Tractor Maintenance, AAVIM 1975.

CRITERION EVALUATION: Both the lubricant and the lubrication level will be correct according to manufacturer's specifications. Both fill and drain plugs will be tight.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING LUBRICATION SYSTEM

COMPETENCY: Pack wheel bearings

PERFORMANCE OBJECTIVE: Give a mechanic's tool set, replacement parts, number 2 lithium grease, and shop rags , pack the wheel bearings on the designated tractor.

PERFORMANCE GUIDE:

1. Lock the brakes, raise and block up the front end.
2. Remove hub cap, cotter pin, adjusting nut, thrust washer, and other bearing cone.
3. Pull off the wheel hub containing bearing cups cone, and outer half of seal.
4. Remove the inner half of seal from the spindle.
5. Remove the inner cone, bearing cups, and outer seal half from the hub.
6. Clean all parts thoroughly.
7. Inspect bearing cups and cones for wear or damage. Replace if necessary.
8. Pack each bearing with No. 2 lithium grease. Fill the space around each roller.
9. Install bearing cups, inner bearing cone, and new outer seal half edge in 3/16" below the inner hub face.
10. Install a new inner seal half on to the spindle with the curved face inward.
11. Lubricate the seal surfaces with No. 2 lithium grease.
12. Install outer cone into the hub.
13. Install hub assembly onto the spindle.
14. Install the thrust washer and adjusting nut. Tighten nut against thrust washer until the pressure causes a drag while the hub and wheel is turned. Back off the nut until the next slot in the nut lines up with the hole in the spindle. If any end play is noticed, tighten the nut. (Torque according to specifications.)
15. Lock the slotted adjusting nut with a new cotter pin and reinstall the hub cap.

LEARNING ACTIVITIES:

1. Consult the operators manual or I & T Shop Manual for instructions in dismantling the front system of the tractor.

2. Read pages 169-172, Fundamentals of Machine Operation Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

3. Read pages 114-119, Tractor Maintenance, AAVIM 1975.

4. Complete the following questions:

   A. How often should you service the wheel bearings on a tractor?
   B. Why is it important to keep the wheel bearings and surrounding area free from dirt?
   C. Why should you never allow the bearings to fall on the ground or the floor?
   D. List the steps you would follow for cleaning the wheel bearings.
   E. List the steps you would follow when repacking and assembling the bearings.
   F. List the steps you would follow for adjusting spindle-type wheels.
   G. List the steps you would follow for adjusting axle-type wheels.

SUPPLEMENTAL READINGS:

1. Fundamentals of Service-Bearings and Seals, Deere and Co., Moline, Ill., Second Edition, 1974.

2. Page 10, Tractor Operation and Daily Care, AAVIM, 1970.

CRITERION EVALUATION: When job is completed, there will be no drag or end play. The following steps will be completed acceptably.

1. Brakes locked
2. Front end blocked
3. Damaged parts replaced, if needed
4. Packing satisfactory
5. Installation and assembled

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING LUBRICATION SYSTEM

COMPETENCY: Service oil coolers

PERFORMANCE OBJECTIVE: Given a parts cleaning tank, flare nut wrenches, an air supply and flow gun, and a water tank, service the oil cooler.

PERFORMANCE GUIDE:

1. Remove oil cooler.
2. Remove dirt from fins.
3. Clean oil tubes with air hose.
4. Check for leaks.
   a. Plug oil outlet.
   b. Install air hose in inlet and turn on air.
   c. Submerge unit in water.
   d. Watch for bubbles. (If no bubbles appear, there is no leakage. If bubbles do appear, locate and repair leaks or replace cooler.)
5. Reinstall oil cooler.

LEARNING ACTIVITIES:

1. Read pages 7-11 to 7-12, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972.

2. Read pages 60-61, Fundamentals of Machine Operation - Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

3. Service the oil cooler on the designated engine.

SUPPLEMENTAL READINGS:

1. Page 56, Fundamentals of Machine Operation - Tractors, Deere and Co., Moline, Ill., 1974.

2. Section D, Diesel Engine Mechanics, William A Foutes, Mid-America Vocational Curriculum Consortium, 1977.

CRITERION EVALUATION: When service is complete, there will be no visible dirt on the cooler and the cooler will be free of leaks.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING LUBRICATION SYSTEM

COMPETENCY: Service oil pumps

PERFORMANCE OBJECTIVE: Given a complete mechanic's tool set, oil, gaskets, solvent, and sealers, service the oil pump.

PERFORMANCE GUIDE:

1. Remove oil level dip stick and drain out engine oil.
2. Remove any parts necessary to make oil pump accessible, and jack up transmission if necessary.
3. Remove the oil pan sump retaining bolts.
4. Remove oil pan sump.
5. Clean dirt from inside the sump.
6. Scrape gasket material from gasket surface.
7. Wash sump in solvent and dry completely.
8. Check pan for damage (repair or replace if necessary).
9. Replace gasket (gasket surfaces should be clean, position gasket on the cylinder block and apply gasket sealer on gasket, front cover, and oil pan).
10. Reinstall oil pan sump and bolts.
11. Reinstall all other parts.
12. Replace oil and dip stick.
13. Run engine and check for oil leaks and oil pressure.

LEARNING ACTIVITIES:

1. Read pages 7-2 to 7-4, Fundamentals of Service-Engines, Deere and Co., Moline, Ill., 1972, and complete the following questions.

   A. Name two types of oil pumps. Which is the most common?
   B. Describe the two pumps listed above.
   C. Where in each of the two oil pumps listed above, will the most wear occur?
   D. Describe how you would measure the clearance between pump gears and housing.
   E. Describe how you would measure the clearance height on the pump gears.

2. Consult the I & T Shop Service Manual for your tractor in order to find further information in regard to servicing the oil pump.

3. With help of the performance guide, service the oil pump on the designated tractor.

SUPPLEMENTAL READINGS:

1. Section D, Diesel Engine Mechanics, William A. Foutes, Mid-American Vocational Curriculum Consortium, Inc., 1977.
2. Pages 59-60, Fundamentals of Machine Operation - Preventive Maintenance, Deere and Co., Moline, Ill., 1973.
3. Pages 230-231, Diesel Fundamentals, Service, Repair. Bill Toboldt, 1977, The Goodheart-Willcox Co., Inc.

CRITERION EVALUATION: All parts will be correctly reinstalled and there will be no oil leaks.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING LUBRICATION SYSTEM

COMPETENCY: Check transmission and/or differential lubricant levels on a plug equipped tractor.

PERFORMANCE OBJECTIVE: Given a wrench to fit the type of plug head and proper lubricant, check the transmission and/or differential lubricant level on a plug equipped tractor.

PERFORMANCE GUIDE:

1. With plug:
   a. Remove level check plug.
   b. Add lubricant until the lubricant overflows from the check plug hole.
   c. Replace plug. (If oil flows out when plug is removed, no additional oil is necessary.)

LEARNING ACTIVITIES:

1. Read page 88, Tractor Maintenance, AAVIM 1975.

2. Read pages 138-139, Fundamentals of Operation-Preventive Maintenance.

3. Complete the following questions.
   A. How often should you check the transmission and/or differential lubricant levels?
   B. Describe how you can check the lubricant level if your machine doesn't have a dipstick.

4. Consult the Farm Tractor Tune-Up and Service Guide, AAVIM 1972, for information regarding gear oil type and viscosity.

5. Check the transmission and/or differential lubricant level on a designated tractor equipped with a plug.

CRITERION EVALUATION: The engine will have the proper oil level as specified in operator's manual and the plug will be tight when the operation is complete.

SECTION XII Maintaining and Servicing Clutches

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2. Service a Dry Clutch 200

3. Service an Expanding Shoe Clutch 201

4. Service a Magnetic Clutch 202

5. Service an Overrunning Clutch 203

6. Service a Wet Clutch 204

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING CLUTCHES

COMPETENCY: Adjust clutch free play

PERFORMANCE OBJECTIVE: Using the clutch on the designated tractor, the service manual, a distance-measuring device and the right size open-ended wrench, adjust the clutch free play.

PERFORMANCE GUIDE:

1. Measure the amount of free play in the clutch pedal arm and compare to specifications in the manufacturer's service manual.
2. Loosen nuts on the adjusting yoke located at the lower end of the clutch operating rod. Adjust free play to specification and tighten nuts.

LEARNING ACTIVITIES:

1. Read pages 83-87, Tractor Maintenance, AAVIM, 1975.

2. Read pages 136-137, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1972.

3. Read the section on clutches for your particular tractor in either the I&T Shop Manual or the manufacturer's service manual.

4. Complete the following questions:

   A. What is the function of a clutch?
   B. Define clutch "free-play" or "free travel?"
   C. Why should the clutch always have a certain amount of "free travel?"
   D. When would it be alright not to adjust the clutch?

5. Determine from the Farm Tractor Tune-Up and Service Specifications, AAVIM, how much free travel is needed.

6. Adjust the clutch free travel on the assigned tractor. Follow the directions in the I&T Shop Manual and the Performance Guide.

SUPPLEMENTAL READINGS:

1. Pages 2-5, 2-11-13, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.
2. Page 45, The Operation, Care, and Repair of Farm Machinery, 28th Edition, Deere and Co., Moline, Ill., 1957.
3. Pages 492-493, Mechanics in Agriculture, Lloyd J. Phipps, Second Edition, The Interstate Printers and Publishers, Inc., 1977.

CRITERION EVALUATION: The adjustment will be made to manufacturer's specifications.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING CLUTCHES

COMPETENCY: Service a dry clutch

PERFORMANCE OBJECTIVE: Using the manufacturer's service manual and the necessary tools and replacement parts, service a dry clutch.

PERFORMANCE GUIDE:

NOTE: Check the manufacturer's service manual for proper equipment and procedure for specified clutch. Spring pressure must be controlled and released evenly to avoid injury.

1. Check clutch release and pressure mechanisms (pressure should be even around the clutch.)
2. Adjust release levers so that contact with release bearing will be uniform and the pressure plate will release evenly.
3. Examine clutch and rebuild, if necessary, following instructions in the service manual.
4. Check clutch for free play.
5. Lubricate the pilot bearing, release bearing and release fork sparingly.
6. Make clutch release adjustment following instructions in the service manual.

LEARNING ACTIVITIES:

1. Read pages 2-2 to 2-6, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

2. Study the section on clutches in the I&T Shop Manual or manufacturer's service manual.

3. Complete the following questions:

   A. What type of power equipment uses dry clutches and why?
   B. What is the difference between a dry-type disk clutch and a wet-type disk clutch?
   C. Why should you not use too much lubrication on the clutch pilot bearing?

4. Check your knowledge of trouble shooting procedure for clutches by completing the worksheet on "Diagnosing Problems in Clutches."

5. Service the dry clutch on the assigned tractor.

CRITERION EVALUATION: When servicing is complete, the clutch will operate according to manufacturer's specifications, and there will not be excessive lubrication of the bearings or release fork.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING CLUTCHES

COMPETENCY: Service an expanding shoe clutch

PERFORMANCE OBJECTIVE: Using the service manual, solvents, lubricants, replacement parts and the necessary tools, service an expanding shoe clutch.

PERFORMANCE GUIDE:

NOTE: There are two types of expanding shoe clutches: (1) the centrifugal type, and (2) the mechanical type.

1. Determine clutch type and specification by reading the manufacturer's service manual.
2. Remove all parts necessary to reach clutch following instructions in the service manual.
3. Check, repair or replace where indicated:
   a. the outer member
   b. the inner member
   c. the clutch release bearing
   d. the pivot links
   e. the vanes and vane spacing centrifugal type
   f. the shoes
4. Clean all parts and lubricate with the recommended lubricants.
5. Reassemble according to recommendations in the service manual.

LEARNING ACTIVITIES:

1. Read pages 2-10 to 2-19, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

2. Make a list of things to watch for when servicing clutches.

3. Read the section on clutches for the assigned tractor in either the I&T Shop Manual or the manufacturer's service manual.

4. After completing the above activities, service an expanding shoe clutch on the designated tractor.

CRITERION EVALUATION: Disassembly to reassembly will be in the order specified by the manufacturer. All worn and damaged parts will be repaired or replaced, and the serviced clutch will function as specified.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING CLUTCHES

COMPETENCY: Service a magnetic clutch

PERFORMANCE OBJECTIVE: Given end wrenches, jumper wire, and a pulley puller, service a magnetic clutch installing a new coil if necessary.

PERFORMANCE GUIDE:

1. If clutch fails to engage when it should, run a jumper wire from the "hot" terminal of the battery to the clutch coil input. If the coil ground is satisfactory and the jumper will not energize the clutch, the coil is defective and must be replaced.
2. The pulley, clutch plate, and bearing are generally removed and replaced as a unit. This unit must be removed with an appropriate puller to gain access to the coil.
3. Remove the old coil and install the new coil in the same position (correct positioning is essential to satisfactory operation).
4. Reinstall pulley assembly.
5. Spin pulley to check for interference.
6. Check clutch for proper operation.
7. Repeat step 1.

LEARNING ACTIVITIES:

1. Read pages 2-9, 2-13 to 2-14, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

2. Read the section on clutches for the designated tractor in either the manufacturer's service manual or the I&T Shop Manual.

3. Complete the following questions:

   A. What are two types of magnetic clutches?
   B. Describe each of them.
   C. What should you look for if the clutch suddenly lost its power and failed to operate.
   D. If those components are okay, what should you check next?

4. Service a magnetic clutch in the shop area. Check the specifications on each clutch for correct input, amperage, and resistance per the machine service manual.

CRITERION EVALUATION: Upon completion of the task, the pulley will spin without interference and the clutch will engage properly.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING CLUTCHES

COMPETENCY: Service an overrunning clutch

PERFORMANCE OBJECTIVE: Given a defective overrunning clutch, the manufacturer's service manual, testing equipment, replacement parts and the necessary tools, service the clutch.

PERFORMANCE GUIDE: NOTE: There are three basic types of overrunning clutches: (1) roller, (2) cam or sprag, and (3) spring.

1. Refer to manufacturer's service manual to obtain information on servicing and lubricating the specific overrunning clutch in question.
2. Test, repair or replace, damaged parts according to instructions in the service manual.
3. Reassemble clutch and test to see if it meets manufacturer's specifications. Adjust if necessary.

LEARNING ACTIVITIES:

1. Read pages 2-7 to 2-9, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

2. Refer to the I&T Shop Manual or the manufacturer's service manual for information on servicing and lubrication.

3. Complete the following:

   A. An overrunning clutch will automatically _____ in one direction, but will _____ in the other.
   B. Describe the difference between the roller, cam or sprag, and the spring overrunning clutches.
   C. Failure to _____ defeats the purpose of this clutch and can result in _____ _____.

4. Service the designated overrunning clutch in the shop area. Follow the steps given in the Performance Guide.

CRITERION EVALUATION: Disassembly and reassembly will follow manufacturer's instructions and the clutch will operate to specifications. There will be no unnecessary damage to any parts.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING CLUTCHES

COMPETENCY: Service a wet clutch

PERFORMANCE OBJECTIVE: Given the manufacturer's service manual, new seals, the specified oil and the necessary tools, service a wet clutch.

PERFORMANCE GUIDE:

1. Check oil level and look for traces of oil leakage.
2. Disassemble following directions in the manufacturer's service manual. Check to see if:
   a. Oil circulates properly.
   b. Lines are clogged on units equipped with pumps.
   c. Inlet lines or filter are dirty. Correct problem if indicated.
3. Check (and replace as needed) the oil seals located at the clutch release fork, flywheel, and clutch shaft end of the housing.
4. Reassemble clutch parts.
5. Check type and grade of oil specified by manufacturer and add oil if necessary.

LEARNING ACTIVITIES:

1. Read page 2-6, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

2. Read the section on clutches for the assigned tractor in the I&T Shop Manual or the manufacturer's service manual.

3. Complete the following:

   A. How does a wet-type disk clutch operate?
   B. What advantage does operation in oil provide?
   C. What is the difference between a wet and dry-type clutch?
   D. What will happen if you fail to keep oil in the clutch housing?

4. Service the wet clutch on the designated tractor. Follow the procedure given in the Performance Guide.

CRITERION EVALUATION: Upon completion there will be no leaks and the oil level will be to specifications.

SECTION XIII Maintaining and Servicing Hydraulics

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16. Trouble-Shoot a Hydraulic-Assist Transmission 232

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING HYDRAULICS

COMPETENCY: Change hydraulic filters

PERFORMANCE OBJECTIVE: Given the new filters recommended in the manufacturer's service manual, the necessary tools, new parts and clean oil if needed, change the hydraulic oil filters.

PERFORMANCE GUIDE: NOTE: The location of the filters varies with the design of the machine. The filter may be an integral part of the machine or hooked into an outside line. Filters in a full-flow system are usually located in the pump inlet and return lines to the reservoir. They may be located in front of (or to the rear of) other hydraulic components. In a by-pass filter system the filter is connected to a tee in the pressure line.

1. Read manufacturer's service manual to determine location of filters.
2. Remove all parts necessary to reach and remove old filters.
3. Install the filters recommended by the manufacturer, following instructions in the service manual.
4. Follow manufacturer's recommendation, if oil change in the hydraulic system is indicated.
5. Reassemble and reinstall all parts removed.
6. After oil is filled to correct level, check operation of hydraulic system and check for leaks.

LEARNING ACTIVITIES:

1. Read Chapter 7, Fundamentals of Service-Hydraulics, Deere and Co., Moline, Ill., 1972. Answer all questions at the end of the chapter.

2. Read pages 40-44, Hydraulics-Care and Operation, Vol. 1, AAVIM, 1974.

3. Check the I&T Shop Manual or manufacturer's service guide for any information that is needed in addition to that found in the Performance Guide.

4. Check Farm Tractor Tune-Up and Service Specifications, AAVIM, 1972 for type and grade of hydraulic oil needed for your designated tractor.

5. Change the hydraulic filters on the designated tractor. Follow the steps outlined in the Performance Guide.

SUPPLEMENTAL READINGS:

1. Page 11-3, Fundamentals of Service-Hydraulics, Deere and Co., Moline, Ill., 1972.
2. Pages 140-142, Tractor Maintenance, AAVIM, 1975.
3. Pages 153-154, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

CRITERION EVALUATION: The new filters will be the type recommended in the service manual. They will be installed correctly and function as specified.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING HYDRAULICS

COMPETENCY: Clean and flush the hydraulic system

PERFORMANCE OBJECTIVE: Given the manufacturer's service manual, the correct type of hydraulic oil and the tools needed, clean and flush a hydraulic system.

PERFORMANCE GUIDE:

NOTE: Most chemical cleaners and solvents are not recommended for flushing hydraulic systems. Check manufacturer's recommendations. Caution: Relieve all hydraulic pressure before disconnecting any parts of the system and discharge the accumulator if used. Do not let solvents come in contact with packing or seals.

1. Drain the system as recommended in the service manual.
2. Clean sediment from the reservoir.
3. Clean the filter elements or remove if needed.
4. Flush out the old oil remaining in the system using the hydraulic fluid recommended by the manufacturer.
5. Introduce specified amount of flushing oil and operate the equipment to cycle the flushing oil through the system.
6. Run oil through system until satisfactorily cleaned (from 4-48 hours).
7. Drain out flushing oil and reinstall the system's filters.
8. Refill the system with clean hydraulic oil of the recommended type.

LEARNING ACTIVITIES:

1. Read the I&T Shop Manual for the designated tractor to learn correct flushing procedures.
2. Read pages 152-154, Fundamentals of Machine Operation-Preventive Maintenance, and answer the following questions:

   A. How often should you drain your tractor's hydraulic system?
   B. Why should you drain and flush the hydraulic system?
   C. When should you flush the system?
   D. List two reasons why you should NOT use most common solvents and chemical cleaners on the market today.
   E. What hydraulic fluid should you use when flushing the hydraulic system?

3. Read pages 46-48, Hydraulic Systems for Tractors and Other Mobile Equipment, AAVIM, and answer the following questions:

   A. Why should the hydraulic fluid be thoroughly heated before the fluid is changed?
   B. Why should the tractor be on level ground before draining the fluid?
   C. If the fluid is milky, what problem is indicated?

4. Check in your operator's manual or Farm Tractor Tune-Up and Service Specifications, AAVIM, for the proper type of hydraulic fluid needed in the designated tractor before you refill it.

5. Flush the hydraulic system on the designated tractor. Follow the outline given in the Performance Guide.

SUPPLEMENTAL READINGS:

1. Read pages 138-142, Tractor Maintenance, AAVIM, 1975.
2. Read pages 11-4 to 11-5, Fundamentals of Service-Hydraulics, John Deere, 1969.
3. Read pages 40-42, Tractor Engine Tune-Up, West Virginia University Publication, 1973.

CRITERION EVALUATION: There will be no damage to the system. Flushing will continue until the system is clean. The recommended oil will be used.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING HYDRAULICS

COMPETENCY: Drain and refill a designated hydraulic system

PERFORMANCE OBJECTIVE: Given the service manual, new hydraulic oil and the necessary tools, drain and refill the hydraulic system.

PERFORMANCE GUIDE:

1. Follow recommendations in the manufacturer's service manual for draining the system. Drain the system foll wing the procedures in the service manual.
2. Replace and tighten drain plug.
3. Clean the area around the filler cap.
4. Check service manual for specified level of recommended hydraulic oil. Fill with oil to recommended level using only clean oil, funnels, and containers.
5. Replace filler cap.
6. Start the engine and warm the system before running the equipment through a working cycle 4-5 times to bleed air from the system.
7. Add more oil if needed and run the machine until it functions smoothly at full capacity.
8. Stop machine and recheck oil level, adding new oil if necessary to reach recommended level.

LEARNING ACTIVITIES:

1. Read pages 47-48, Hydraulic Systems for Tractors and Other Mobile Equipment, Vol. 2, AAVIM and answer each of the following questions.

   A. List four steps you would use when changing the hydraulic fluid and the reason you would follow each of those steps.
   B. Why should you check your operator's manual before changing the hydraulic fluid?

2. Read pages 140-142, Tractor Maintenance, and answer the following question:

   A. How do you change the hydraulic fluid if the oil supply comes form the gear case?

3. Check in your operator's manual or Farm Tractor Tune-up and Service Specifications, AAVIM, for the type of hydraulic fluid needed in your tractor.

4. Drain and refill the designated hydraulic system.

SUPPLEMENTAL READINGS:

1. I&T Shop Manual, Technical Publications, Inc.
2. Pages 11-4 to 11-5, Fundamentals of Service - Hydraulics, Deere and Co., Moline, Ill., 1972.
3. Pages 152-154, Fundamentals of Machine Operation - Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

CRITERION EVALUATION: The oil added will be that recommended by the manufacturer, the oil will be at the correct level, and the system will operate smoothly as determined by the instructor.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING HYDRAULICS

COMPETENCY: Operate and analyze with a hydraulic tester

PERFORMANCE OBJECTIVE: Given an operator's manual, a hydraulic tester, operating instructions and the needed tools, measure the oil flow pressure, and temperature on the designated tractor.

PERFORMANCE GUIDE:

NOTE: A hydraulic tester (analyzer or test gauge) will measure oil flow, pressure, and temperature. It will also isolate faulty components.

1. Read the instruction manual furnished by the manufacturer of the hydraulic tester. Read the service manual of the tractor for specifications on relief valve pressures, pump output, operating temperature and engine RPM.
2. Steam clean the machine and plug all openings to keep out dirt.
3. Disconnect the oil lines following instructions from manufacturers of tractor and tester.
4. Connect tester as recommended and check for: temperature, flow, pressure, leakage.
5. To operate the hydraulic tester: With tester load valve open, record the maimum pump flow at no pressure; close the load valve slowly to increase pressure; record the flow at 250 psi increments from no pressure to maximum pressure; record results; open hydraulic tester load valve until the maximum pump flow is again at no pressure; shut off engine.
6. Analyze with the hydraulic tester: Check manufacturer's specifications and compare readings, especially for pump test. If the pump test is satisfactory, run a system test following manufacturer's instructions. Diagnose problems (or freedom from problems) by comparing results with specifications.

NOTE:
A. If flow at each pressure is the same as for the pump test, it means there are no problems with any component.
B. If pressure drops prior to the time full load is reached, one of the circuits is malfunctioning.
C. If flow drops with the control valves in position, the relief valve may be the cause of trouble. Check service manual.

LEARNING ACTIVITIES:

1. Read pages 12-5 to 12-8, Fundamentals of Service-Hydraulics, Deere and Co., Moline, Ill., 1972.

2. Read carefully the manufacturer's instruction manual for the hydraulic tester. Become very familiar with how it should be used.

3. Obtain Hydraulic Tester Self Test from your instructor.

4. Measure the oil flow, pressure, and temperature on the designated tractor and record your results. Follow the steps outlined in the Performance Guide.

SUPPLEMENTAL READINGS:
1. Pages 6, 22, 23, 34, 48, 49, 62, Hydraulics-Inspecting and Testing, AAVIM, 1974.
2. I&T Shop Manual, Technical Publications, Inc.

CRITERION EVALUATION: The results of the test will be within 5% of the results obtained by the instructor, and all precautions will be taken not to damage any parts.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING HYDRAULICS

COMPETENCY: Repair hydraulic assist transmissions

PERFORMANCE OBJECTIVE: Given the manufacturer's service manual, the necessary tools, replacement parts, and testing equipment, repair the hydraulic assist transmission.

PERFORMANCE GUIDE:

1. Trouble shoot the hydraulic assist transmission following instructions in the manufacturer's service manual to determine if repairs are needed in the clutches or the gear train.
2. Remove all parts necessary to reach the transmission.
3. Disassemble transmission following instructions in the service manual, noting location of parts. Clean and inspect parts for wear and/or damage. Repair or replace parts as needed.
4. Reassemble in the order specified in the service manual. Install new seals as needed.
5. Check out system as specified in the service manual and make adjustments if indicated.

LEARNING ACTIVITIES:

1. Read Chapter 4, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

2. Answer all the questions at the end of Chapter 4.

3. Read pages 132-133, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

4. Construct a trouble shooting chart. Refer to page 4-11, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

5. With the help of the Performance Guide, repair a hydraulic assist transmission on the designated tractor.

SUPPLEMENTAL READING:

1. I&T Shop Manual, Technical Publications, Inc. Kansas City, Mo.

CRITERION EVALUATION: All parts will be disassembled and reassembled according to manufacturer's instructions. There will be no damage to any parts. Replacement parts will be those specified by the manufacturer, and the system will function to specifications.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING HYDRAULICS

COMPETENCY: Repair hydraulic cylinders

PERFORMANCE OBJECTIVE: Given a hydraulic testing machine, a service manual, replacement parts and the necessary tools, repair a hydraulic cylinder.

PERFORMANCE GUIDE: NOTE: There are two main types of hydraulic cylinders--piston type which gives straight movement and vane type which gives rotary movement. Check manufacturer's service manual for specifics and variations as well as repair instructions.

1. Test and diagnose the specific problem on a hydraulic testing machine following instructions in the manufacturer's service manual and the instructions which come with the testing machine. The following are possible causes and cures:
   a. Outside leaks:
      --tighten end caps
      --replace gasket
      --replace packing around piston rod
      --turn seal lip toward pressure oil
      --tighten mounting and pivot points
      --replace piston rods if misaligned
      --check and correct, if necessary, piston rod lubrication
      --check for damage due to dirt
   b. Internal leaks:
      --replace piston seals or rings
      --check cylinder walls for scoring caused by grit in oil. Repair, if needed.
   c. Cylinder creeping:
      --check for internal leaks
      --replace control valve
   d. Sluggish operation:
      --check for internal leaks
      --check for air in cylinder
      --check for oil of too high viscosity
      --test for worn parts
   e. Loose mounting:
      --check pivot points and mounts
   f. Misalignment:
      --see if piston rods are galled or bent
      --check packing
   g. Lack of lubrication:
      --check piston rods

h. Abrasives on rods:
--Clean out grit, replace seals
--check rods for rust and repair
i. Burrs on piston rod:
--clean with crocus cloth and replace seal

2. Check service manual for other causes of malfunction for specific system.
3. Complete indicated repairs.

LEARNING ACTIVITIES:

1. Read Chapter 4, Fundamentals of Service-Hydraulics, Deere and Co., Moline, Ill., 1972.

2. Answer all of the questions at the end of Chapter 4, Fundamentals of Service-Hydraulics, Deere and Co., Moline, Ill., 1972.

3. Read pages 21-22, Hydraulics-Inspecting and Testing, AAVIM, 1974.

4. Examine the vane type and the piston type hydraulic cylinders supplied by the instructor.

5. Repair a hydraulic cylinder on the designated tractor. Follow the suggested steps in the Performance Guide.

SUPPLEMENTAL READING: 1. I&T Shop Manual, Technical Publications, Inc. Kansas City, Mo.

CRITERION EVALUATION: The repaired cylinder will not leak, and it will operate correctly.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING HYDRAULICS

COMPETENCY: Replace hydraulic fittings

PERFORMANCE OBJECTIVE: Given a new fitting, the necessary tools and replacement parts, hydraulic oil, replace the hydraulic fitting.

PERFORMANCE GUIDE:

1. Identify faulty fitting. Note: Oil leakage, air in the system or incorrect coupler function indicate need for replacing fittings.
2. Relieve pressure from lines before disconnecting parts.
3. With suitable wrench, remove line or hose from fitting. Plug lines to prevent dirt from entering system.
4. Remove fitting, checking to see cause of leakage.
5. Check threads, flanges and flairs for burrs or nicks which could cause damage to new filter.
6. Select new fitting which matches old fitting in size, thread and type.
7. Where needed, install sealing O-ring on fitting. Being careful not to cut the O-ring on the threads.
8. Install fitting to correct tightness. If a lock nut is used, install to correct angle and tighten lock nut down.
9. Install line on fitting to be sure it is free and has no twist or bend.
10. Tighten line making sure that the sealing flange does not turn. Do not over torque.
11. Operate system and see if leak has been stopped.
12. Refill the hydraulic system to desired level.

LEARNING ACTIVITIES:

1. Read pages 8-13 to 8-16, Fundamentals of Service-Hydraulics, Deere and Co., Moline, Ill., 1972, Second Edition.

2. Read pages 148-150, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

3. Complete the following questions:

   A. Why should you never expose bare skin to pinhole leaks?
   B. What are the two basic types of fittings available? What is the difference between them?
   C. More damage has been done to tube fittings by _____ than from any other cause.

4. Replace the hydraulic fitting on the designated tractor.

CRITERION EVALUATION: The hydraulic fitting will be replaced so that it does not leak under operating pressure.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING HYDRAULICS

COMPETENCY: Service and adjust hydraulic assist transmissions

PERFORMANCE OBJECTIVE: Given the manufacturer's service manual, the necessary tools and testing equipment, needed replacement parts, fresh oil and lubricants, service and adjust a hydraulic assist transmission.

PERFORMANCE GUIDE:

1. Read manufacturer's service manual to determine the type of hydraulic assist transmission in question.
2. Trouble shoot the system following directions in the service manual. Check these points:
   - --low system pressure
   - --transmission overheating
   - --clutches or brakes slipping
   - --machine won't operate
   - --shifts erratically
   - --inching pedal
   - --disconnect clutch
   - --tow disconnect
   - --lubricating oil route
   - --control oil route
   - --others specified in service manual
3. Service and adjust the system following service manual directions.
4. Run motor and check out system making additional adjustments as indicated.

LEARNING ACTIVITIES:

1. Read Chapter 4, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.
2. Answer the questions at the end of Chapter 4, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.
3. Consult the I&T Shop Manual or the manufacturer's service manual to determine the type of hydraulic assist transmission and the correct trouble shooting procedure for the assigned tractor.
4. Service and adjust the hydraulic assist transmission on the designated tractor.

SUPPLEMENTAL READING:

1. Pages 132-133, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

CRITERION EVALUATION: All service and adjustments will be according to manufacturer's instructions. There will be no damage to any part and the transmission will operate to specifications.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING HYDRAULICS

COMPETENCY: Servece and repair hydraulic gear pumps

PERFORMANCE OBJECTIVE: Given a set of mechanic's tools, service manual, micrometer, torque wrench, clean rags, replacement parts, and hydraulic fluid, service the hydraulic gear pump on the designated tractor.

PERFORMANCE GUIDE:

1. Remove pump from unit and plug lines to prevent dirt from entering unit.
2. Clean unit completely of all dirt and grime.
3. Remove front cover bolts and check to see if all are the same length (if not, note where different bolts are placed).
4. Make a scribe mark on top, middle section, and bottom section so reassembly can be done correctly.
5. Remove top cover, thrust plate, springs, and check bolts from top plate.
6. If back cover is bolted on, remove now. Take out back thrust plate and other parts.
7. Note gear position and remove from housing.
8. Check gears for teeth wear on ends and faces of teeth.
9. Measure gear shafts and gears. Compare with recommended specifications and replace if necessary. Install new gears as complete sets only.
10. Check gear housing for scratches or physical damage. If damage is noticeable around housing, pump will not produce adequate pressure and should be replaced.
11. Check end-thrust plates for scratches or breaking of bronze coating.
12. Remove top seal layers and check for blown rubber section in seal unit.
13. If seal must be removed, use great care. The work must be very accurate or the new seal will not hold adequate working pressure.
14. Install new main rubber seal to body with vee groove to the bottom of the pattern channel.
15. Seat the seal carefully and completely all around using a blunt tool.
16. Install fiber gasket and metal gasket and seat. Use care not to break or distort the gaskets.
17. Install gears into body in correct order.
18. Install thrust plates with bronze coating toward gears.
19. Install check valve bolts, springs, and shaft seal on head. Mount to body of pump in correct order.

20. Install bolts and tighten lightly.
21. Make sure pump turns freely.
22. Tighten bolts to recommended torque with a crossing torqueing sequence.
23. Reinstall to machine.
24. Run machine lightly until all parts lubricate correctly then bring to full working load gradually.

LEARNING ACTIVITIES:

1. Read pages 2-1 to 2-4 and 2-13 to 2-20, Fundamentals of Service-Hydraulics, Deere and Co., Moline, Ill., 1972.

2. Study the three types of hydraulic pumps. Be able to identify a gear pump from the other two types of pumps

3. Read the section on the hydraulic pump for the designated tractor in either the I&T Shop Manual or the manufacturer's service guide.

4. Read pages 30-35, Hydraulics-Inspecting and Testing, AAVIM, 1974.

5. Answer questions 1-5 and 8-12 at the end of Chapter 2, Fundamentals of Service-Hydraulics, Deere and Col, Moline, Ill., 1972.

6. Service the hydraulic gear pump on the designated tractor. Follow the steps outlined in the Performance Guide.

SUPPLEMENTAL READING:
1. Chapter 8, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

CRITERION EVALUATION: The student will clean, disassemble, repair, and reassemble pump according to manufacturer's specifications in 1-½ hours.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING HYDRAULICS

COMPETENCY: Service and repair hydraulic radial piston pumps

PERFORMANC OBJECTIVE: Given the correct wrenches, a dial indicator, micrometer, service manual, torque wrench, new parts as required, clean rags, hydraulic fluid, and container for individual sections for pump parts, service a radial piston pump on designated tractor.

PERFORMANCE GUIDE:

1. Remove pump from unit after draining oil and plugging line to prevent entrance of dirt.
2. Attach a dial indicator to pump and check shaft end play. (Check against manufacturer's specifications and not for use during reassembly.)
3. Remove front bolts and remove stroke control unit as an assembly. Do not lose shims under shaft bearing cap.
4. Place the entire unit into individual trays so that all parts can be matched when reinstalling.
5. Remove discharge valve guides, springs, and valve from front of pump.
6. Remove plugs, springs, and piston from the outside of pump.
7. Inlet valve and discharge valve seats are pressed into housing and should not be removed unless removal is indicated.
8. After plugs have been removed, remove inlet valve by tapping with a punch through the discharge valve seat.
9. Remove discharge valve seat by tapping with a punch through the inlet valve opening.
10. Remove pump camshaft and bearings by tapping with a soft hammer on the splined end of the shaft.
11. Remove strap ring and remove air seal.
12. Check all surfaces for wear or other damage.
13. Measure the lift of all inlet valves. Make sure they are not loose and within manufacturer's specifications.
14. Test piston spring with spring tester. (They should be to specifications and even throughout.)
15. Measure the other parts of the pump and compare to recommended specifications. If not to specifications, replace parts.
16. Press new shaft air seal into bore just far enough to be able to install snap ring.
17. Reverse disassembly procedure for reassembly. Be sure to clean and coat all parts with fresh hydraulic oil upon assembly to prevent wear and binding.

18. If stroke control mechanism is to be checked, do so at this time.
19. Remove stroke control valve and crankcase outlet valve and check for smooth surfaces.
20. Put valve back together carefully, making sure all parts are properly positioned and lubricated. Reinstall all shims under crankcase outlet valve. Adjustment must be made when back on unit.
21. Reinstall stroke control body to pump and torque both properly making sure end play is correct.
22. Reinstall pump to unit and oil slowly until the system is filled and lubricated correctly.
23. Take a pressure reading to determine when crankcase outlet valve is opening and add or take out shims until correct pressure is obtained.
24. Rotate adjustment screw of stroke control valve until main system pressure is correct.
25. Check for leaks.

LEARNING ACTIVITIES:

1. Read pages 2-1 to 2-3, 2-7 to 2-22, Fundamentals of Service-Hydraulics, Deere and Co., Moline, Ill., 1972.

2. Answer questions 1-5, 7, 9-12 at the end of Chapter 2, Fundamentals of Service-Hydraulics, Deere and Co., Moline, Ill., 1972.

3. Study the samples of three types of hydraulic pumps. Be able to identify the radial piston pump from the other two types of hydraulic pumps.

4. Read the section on hydraulic pumps in I&T Shop Manual or the manufacturer's service manual for the designated tractor.

5. Service a radial pump on the designated tractor.

SUPPLEMENTAL READINGS:
1. Pages 25-30 and 32-35, Hydraulics-Inspecting and Testing, AAVIM, 1975.
2. Chapter 8. Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

CRITERION EVALUATION: The pump will be rebuilt so it is within the manufacturer's operating specifications for GPM and pressure.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING HYDRAULICS

COMPETENCY: Service and repair hydraulic motors

PERFORMANCE OBJECTIVE: Given the manufacturer's service manual, testing equipment, necessary tools, replacement parts, and fresh oil, service a hydraulic motor on the designated tractor.

PERFORMANCE GUIDE:

NOTE: There are three basic types of hydraulic motors: gear, vane, and piston. Gear motors have two basic designs--external and internal, and piston motors also come in two basic designs--axial and radial. Check the manufacturer's service manual for type and service instructions.

1. Trouble-shoot the motor following instructions in the service manual for causes of:
   --motor failure.
   --slow motor operation.
   --erratic motor operation.
   --motor turns in wrong direction.
   --motor shaft not turning.
2. Disassemble motor following instructions in the service manual.
3. Clean and inspect all parts. Replace all worn or damaged parts.
4. Keeping all parts clean, reassemble motor in order recommended. Replace all seals and gaskets with new ones.
5. Replace old oil with new.
6. Operate motor and check for excessive pressure, speed, torque, displacement, load and temperature. Adjust to manufacturer's specifications.

LEARNING ACTIVITIES:

1. Read Chapter 5, Fundamentals of Service-Hydraulics, Deere and Co., Moline, Ill., 1972.

2. Complete all the questions at the end of Chapter 5, Fundamentals of Service-Hydraulics, Deere and Co., Moline, Ill., 1972.

3. Compare Figure 3 on page 5-2 with Figure 4 on page 2-2, Fundamentals of Service-Hydraulics, Deere and Co., Moline, Ill., 1972.

4. Service the hydraulic motor on the designated tractor. Follow the outline given in the Performance Guide.

SUPPLEMENTAL READINGS:
1. I&T Shop Manual, Technical Publications Inc., Kansas City, Mo.
2. Pages 52-62, Hydraulics-Inspecting and Testing, AAVIM, 1974.

CRITERION EVALUATION: The disassembly and reassembly will follow manufacturer's instructions. All parts will be cleaned and worn or damaged parts replaced. The pressure, speed, torque, displacement, load and temperature will be adjusted to manufacturer's specifications.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING HYDRAULICS

COMPETENCY: Service and repair hydrostatic drive

PERFORMANCE OBJECTIVE: Given the manufacturer's service manual, steam cleaning equipment, the necessary clean and grease-free tools and supplies, a clean working area, and replacement parts and oil, service a hydrostatic drive pump and motor.

PERFORMANCE GUIDE:

NOTE: Keep working area clean at all times, and seal any openings when doing service work to keep dirt from entering system.

1. Using proper test equipment, follow the procedure outlined in the manufacturer's service manual to test the system and locate any problem areas.
2. Prior to disassembling the pump or motor, have ready:
   --several clean plastic plugs to seal openings when removing the lines or hoses.
   --several clean plastic bags to place over open ends of lines or hoses and rubber bands to secure bags.
   --a clean container of solvent and a compressed air unit to wash and dry internal parts.
   --a clean container of transmission fluid to use on internal parts as they are reassembled.
   --petroleum jelly to lubricate surfaces where recommended in the service manual.
3. Disassemble following directions in the service manual.
4. Clean and inspect all parts replacing worn or damaged parts as needed.
5. Reassemble following directions in the service manual. Install new O-rings, seals, and gasket to seal mating parts and prevent leakage.
6. Replace oil supply and check for correct level.
7. Test the system following the procedure outlined in the service manual; make adjustments if needed.

LEARNING ACTIVITIES:

1. Read Chapter 5, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

2. Complete the questions at the end of Chapter 5, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

3. Read the section on hydrostatic drive pump and motor for the designated tractor in either the manufacturer's service manual or the I&T Shop Manual.

4. Consult Farm Tractor Tune-Up and Service Specifications, AAVIM, 1972, for the oil recommended for the hydrostatic drive system.

5. Using the Performance Guide, service the designated hydrostatic drive system.

CRITERION EVALUATION: All parts will be disassembled and reassembled following manufacturer's instructions. Working area and all parts will be clean. No dirt, lint, or chaff will enter the system. The system will operate to manufacturer's specifications with no leakage.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING HYDRAULICS

COMPETENCY: Service and repair hydraulic pumps

PERFORMANCE OBJECTIVE: Given the manufacturer's service manual, a clean working area, the necessary tools, replacement parts and fluids, service and repair a hydraulic pump.

PERFORMANCE GUIDE:

NOTE: Hydraulic pumps have three basic designs: gear pumps, vane pumps, and piston pumps. Check manufacturer's service manual for specific insturctions on service and repair. Gear pumps come in two basic types, external and internal. Vane pumps come in two basic types, balanced and unbalanced. Piston pumps come in two basic types, axial and radial.

1. Following instructions in the manufacturer's service manual, troubleshoot the pump to diagnose the problem. Check for:
   --proper fluid and fluid level
   --fluid contamination
   --seal damage
   --overleading or overspeeding
   --cavitation
   --worn or damaged parts
   --noise
   --excessive wear
   --fluid delivery
   --pressure (no pressure, low, or erratic pressure)
   --excessive fluid leakage
2. Disassemble pump following manufacturer's instructions and plugging lines to keep dirt out of system.
3. Clean and inspect all parts replacing any worn or damaged parts.
4. Reassemble pump replacing seals and gaskets according to manufacturer's instructions.
5. Replace fluid and check out pump, making adjustments if needed.

LEARNING ACTIVITIES:

1. Read pages 2-1 to 2-13, Fundamentals of Service-Hydraulics, Deere and Co., Moline, Ill., 1972.

2. Read pages 23-35, Hydraulics-Inspecting and Testing, Vol. 2, AAVIM, 1974.

3. Study three types of pumps provided by the instructor.

4. Read the section on hydraulic pumps in either the I&T Shop Manual or the manufacturer's service manual.

5. Consult the charts on pages 2-19 to 2-20, Fundamentals of Service-Hydraulics, Deere and Co., Moline, Ill., 1972 for diagnosing your hydraulic pump's problem.

6. Service and repair the designated hydraulic pump. Follow the steps given in the performance guide.

SUPPLEMENTAL READING:
1. Pages 158 and 159, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

CRITERION EVALUATION: There will be no damage to any parts. No dirt, lint or chaff will enter the system and the pump will operate as specified.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING HYDRAULICS

COMPETENCY: Service and repair hydraulic valves

PERFORMANCE OBJECTIVE: Given correct wrenches, a service manual, a micrometer, a hand hydraulic pump with pressure gauge, fittings to attach pump to valve, hydraulic fluid, repair parts and clean rags, service and repair hydraulic valves in a clean work area on the designated tractor.

PERFORMANCE GUIDE: NOTE: These instructions are given for an open-center multi-spool stacked valve assembly but would hold true for unit valves and closed-center valves also.

1. Clean valve unit and remove from system. Be sure to plug line to prevent contamination of the hydraulic system.
2. Place on a clean work bench and remove tie bolts from valve bank.
3. Remove caps and spools from section. Check to be sure spool moves evenly and smoothly.
4. Check spool for cracks, scratches, and straightness. Make sure end sealing surfaces are smooth and no burrs are present.
5. If spool is rough, polish with fine emery cloth making sure the diameter of the spool is not reduced significantly.
6. Check diameter of spools and be sure they are within specifications. If not, replace entire section. Be sure not to mix spools and housing because of drilling and porting.
7. Install new seals to valve body and reinstall spool carefully making sure not to cut seal with spool.
8. Repeat procedure on the rest of the sections.
9. Install new sealing rings between sections and place back together as a complete unit.
10. Tighten tie bolts to correct torque in a cross corner manner. Be sure not to overtighten bolts as a binding of spools could result.
11. If relief valves are located on the bank, attach a hand pump to the outlet part it controls. Check set and retest these relief valves.
12. If the system had a leak-down problem but no relief valve is located on the valve, bring pressure up to the system relief valve pressure and hold. If pressure drops very fast, then an internal leak in the valve spool is indicated. The section will need to be replaced and checked again.

13. Reinstall on machine and connect controls.
14. Operate to see that all circuits are working correctly.

LEARNING ACTIVITIES:

1. Read Chapter 3, Fundamentals of Service-Hydraulics, Deere and Co., Moline, Ill., 1972.

2. Complete all the questions at the end of Chapter 3, Fundamentals of Service-Hydraulics, Deere and Co., Moline, Ill., 1972.

3. Read pages 35-49, Hydraulics-Inspecting and Testing, AAVIM, 1974.

4. Find the defective valve on the designated tractor.

5. Examine the three basic types of valves provided by the instructor.

6. Read the I&T Shop Manual or manufacturer's service manual for information on service and repair of hydraulic valves.

7. Service and repair the hydraulic valves on the designated tractor.

CRITERION EVALUATION: When service is completed, hydraulic circuits will work according to manufacturer's specifications.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING HYDRAULICS

COMPETENCY: Service and repair internal hydraulic pump

PERFORMANCE OBJECTIVE: Given the manufacturer's service manual, a clean working area, the necessary tools and replacement parts, solvents and replacement fluid, service and repair an internal hydraulic pump.

PERFORMANCE GUIDE:

1. Follow instructions in manufacturer's service manual to disconnect and disassemble pump.
2. Clean and inspect the spur gear, internal gear, drive shaft, separator, inlet and outlet openings, and housing. (If pump is a rotor model, clean and inspect all parts.)
3. Replace worn and/or damaged parts.
4. Reassemble following instructions in the service manual, replacing seals.
5. Operate pump and adjust if needed.

LEARNING ACTIVITIES:

1. Read page 2-4, Fundamentals of Service-Hydraulics, Deere and Co., Moline Ill., 1972.

2. Answer the following questions:

   A. What is the difference between an internal and an external pump?
   B. Describe how an internal gear pump operates.
   C. Give the name for a pump that is a variation of the internal gear pump.

3. Read pages 30-35, Hydraulics-Inspecting and Testing, AAVIM, 1974.

4. Complete the Self-Test "Understanding Hydraulic Pumps" provided by the instructor.

5. Distinguish between an internal and external pump provided by the instructor.

6. Service and repair the designated internal hydraulic pump.

CRITERION EVALUATION: There will be no damage to parts. All parts will be clean and correctly reassembled, in good working order. The Pump will function as specified by the manufacturer.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING HYDRAULICS

COMPETENCY: Trouble-shoot a hydraulic-assist transmission

PERFORMANCE OBJECTIVE: Given the manufacturer's service manual, the necessary tools, testing equipment and replacement parts, trouble-shoot a hydraulic-assist transmission.

PERFORMANCE GUIDE:

1. Read manufacturer's service manual for specific trouble-shooting instructions.
   a. If transmission is overheating:
      --The reservoir oil level is too high or too low
      --The oil filter is plugged
      --The core in oil cooler is plugged
      --Not enough lubricating oil flow
      --The clutch or brake is dragging or slipping
      --Faulty temperature gauge
      --The cooler relief valve is stuck open
   b. If machine won't operate:
      --Tow disconnect is disengaged
      --Failed clutch
      --Cold weather starting clutch is disengaged
      --No oil pressure
      --Park lock engaged
      --The control linkage is stuck
      --Blown packing or gaskets
      --The oil filter is plugged
   c. If shifting is erratic:
      --Incorrect setting of adjustable orifice
      --Wrong system oil pressure
      --Failed or stuck accumulator
      --The shift control is disconnected or binding
   d. If there is low system pressure:
      --Failed or worn out pump
      --Pump not turning
      --Stuck collar relief valve
      --Stuck filter by-pass valve
      --Inching pedal valve leaking
      --Incorrect adjustment of pressure regulating valve
      --Air leak in pump suction line
      --Plugged reservoir oil screen
      --Blown O-ring or gasket
      --Low oil level
      --Plugged oil filter
   e. If clutch or brakes are slipping:
      --Oil pressure is low
      --Warped or burned clutch facings
      --Defective seal or gasket
      --Excessive oil leakage at the shift valves

LEARNING ACTIVITIES:

1. Read Chapter 4, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill. , 1972.

2. Complete all of the questions at the end of Chapter 4, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

3. Read the I&T Shop Manual or the manufacturer's service manual to determine the type of hydraulic assist transmission and the specific procedure for correcting any recognized problem.

4. Trouble-shoot the designated hydraulic assist transmission.

CRITERION EVALUATION: There will be no damage to any parts. Replacement parts will be those specified by the manufacturer and the transmission will operate to specifications.

SECTION XIV Maintaining and Servicing Powertrain

1. Measure Backlash and Clearance in Gear Train 234

2. Measure End-Play and Adjust Movement in Gear Shaft 235

3. Preload Bearings in Gear Train 236

4. Service Constant Mesh Transmission (Example: Ford) 238

5. Service Power-Shift Transmission 241

6. Service Sliding-Gear Transmission 243

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING POWERTRAIN

COMPETENCY: Measure backlash and clearance in gear train

PERFORMANCE OBJECTIVE: Given a gear train with too much backlash, a dial indicator, shims, the service manual and the necessary tools, measure the backlash and clearance in a gear train.

PERFORMANCE GUIDE:

1. Follow disassembly instructions in manufacturer's service manual.
2. Clean all parts.
3. Mount a dial indicator on the gear so it registers the full rotary movement of the gear.
4. Adjust backlash reading to specifications with shims.
5. When correct backlash reading is obtained, reassemble all parts according to manufacturer's instructions and specifications.

LEARNING ACTIVITIES:

1. Read page 194, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

2. Read pages 1-14 and 1-20, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

3. Study the power train section of the I&T Shop Manual or the manufacturer's service manual for the designated tractor to determine break-down procedure and backlash reading specifications.

4. Answer the following questions:

   A. What is "backlash"?
   B. What are three things that can cause "backlash"?
   C. What will result from too much "backlash"?

5. With the help of the I&T Shop Manual or the manufacturer's service manual, measure the backlash and clearance in the gear train on the designated tractor.

CRITERION EVALUATION: The dial indicator readings will agree with the instructor's readings. Shims will be correctly installed and final adjustment will be to specifications.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING POWERTRAIN

COMPETENCY: Measure and adjust end-play movement in gear shaft

PERFORMANCE OBJECTIVE: Given a gear shaft with too much end play, the service manual, dial indicator, shims, and necessary tools, measure the end-play movement in the gear shaft.

PERFORMANCE GUIDE: NOTE: Disassembly and reassembly will follow manufacturer's instructions.

1. Follow instructions in manufacturer's service manual to reach gears and shaft.
2. Mount dial indicator against side of a gear or end of a shaft. Pry shaft or gear in both directions and note difference in two readings on dial indicator.
3. Adjust the end play with shims or adjusting nuts to manufacturer's specifications. (Note: It may be necessary to preload the gear train.)

LEARNING ACTIVITIES:

1. Read page 1-20, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

2. Read page 195, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

3. Study the power train section in the I&T Shop Manual or manufacturer's service manual for the designated tractor to determine end-play specifications.

4. Complete the following questions:

   A. What is end-play?
   B. What causes end-play?
   C. Why might it be necessary to preload the bearings?

5. Using the Performance Guide, measure the end-play movement in the gear shaft of the power train on the designated tractor.

CRITERION EVALUATION: The dial indicator readings will agree with those of the instructor. Adjustments will be to manufacturer's specifications.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING POWERTRAIN

COMPETENCY: Preload bearings in gear train

PERFORMANCE OBJECTIVE: Given a gear train which needs preloading, the manufacturer's service manual, shims, a dial indicator and the necessary tools, preload the bearings in the gear train.

PERFORMANCE GUIDE:

NOTE: Preload must fit design of bearings and strength of parts. Check manufacturer's service manual for specific tractor. Gear trains are preloaded with thrust washers, adjusting nuts or with double-race bearings. The following instructions are for ring gear and pinion.

1. Follow instructions in manufacturer's service manual to reach ring gear and pinion.
2. Check adjustments needed with dial indicator, following instructions in service manual. Adjust as necessary with shims and adjusting nuts. Reassemble gear set and adjust to specifications.
   a. Adjust fit of pinion to ring gear with shims under lower shaft bearing.
   b. Use shims under upper shaft bearing to preload pinion shaft bearings. (Install with extra shims, check end-play then remove shims to equal end-play plus specified loads.)
   c. Preload ring gear bearings with shims under side guills. (Install with extra shims, check end-play then remove shims to equal end-play and recommended preload for bearing.)
   d. Transfer shims under side quills to adjust backlash between ring gear and pinion. Check backlash at several points around ring gear. Transfer shims from left quill to right quill to decrease backlash-from right to left quill to increase it.
   e. Consult service manual for exact steps and readings.
   f. Reassemble according to manufacturer's directions.

LEARNING ACTIVITIES:

1. Read page 195, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

2. Read page 1-20, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

3. Study the power train section of the I&T Shop Manual or manufacturer's service manual for the designated tractor to determine the preload specifications.

4. Answer the following questions:

   A. Define "preload" adjustment.
   B. When are gear trains preloaded?
   C. What will happen if bearings are preloaded too tight?
   D. What things are used to preload gear drives?

5. Using the Performance Guide, preload the bearings in the gear train of the designated tractor.

CRITERION EVALUATION: Disassembly and reassembly will be according to service manual. Shims will be correctly installed and adjusted. Final dial indicator readings will agree with those of the instructor and will be to manufacturer's specifications.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING POWERTRAIN

COMPETENCY: Service Constant mesh transmission (Example: Ford)

PERFORMANCE OBJECTIVE: Given the necessary tools, equipment and supplies and the manufacturer's service manual, service a constant mesh transmission.

PERFORMANCE GUIDE:

1. Remove transmission from tractor according to directions in service manual for specific tractor.
2. Remove bolts and lift cover from case.
3. Remove shifter fork spring and detent ball.
4. Disconnect clutch release bearing springs and remove bearing and hub assembly.
5. Remove bolts and lock washers that attach clutch release bearing support assembly to transmission case.
6. Remove input shaft and support assembly as a unit.
7. Loosen lock nut on lock screw in first and third gear shifter fork. Slide shifter rail out of transmission case.
8. Remove shifter fork from its position in outlet shaft connector coupling. Remove the shifter plate pivots and gaskets from each side of housing. Lift plates out of case.
9. Remove bolts and lock washers that hold output shaft bearing retainer on the case. Remove retainer. (Keep shims for reassembly.)
10. Take output shaft gear assembly from case (provide clearance, if necessary by pushing reverse gear shifter fork and second and fourth gear shifter fork forward.)
11. Remove shifter rail spring seat, gasket, spring, detent ball from right side of transmission case. Loosen lock nut on lock screw in second and fourth gear shifter fork and back off screw.
12. Remove shifter rail cap plug from rear of transmission case. Pull shifter rail out of case. Remove shifter fork from counter-shaft connector coupling.
13. Remove bolts and lock washers that hold PTO support and shifter assembly on rear of transmission case. Remove assembly, keeping shims together for reassembly.
14. Remove countershaft assembly, reverse shifter rail spring seat, gasket, spring and detent ball from left side of transmission case.

15. Loosen lock nut on lock screw in reverse gear shift fork. Back off lock screw.
16. Remove shifter rail cap plug from rear of transmission case and pull reverse gear-shift rail out of housing.
17. Remove shifter fork from reverse idle driver gear.
18. Pull reverse idler shaft from its bore in case. Remove gears and thrust washer from transmission. Remove snap ring and O-ring from reverse idle shaft.
19. Clean all parts in suitable solvent. (To clean bearings, rotate in solvent and dry carefully with compressed air. Do not spin.)
20. Inspect all parts for wear or damage. Discard and replace all defective parts including case if necessary.
21. Lubricate parts. Install new oil seals and gaskets.

To disassemble and assemble output shaft:

--Remove rear bearing cup and oil seal from retainer.
--Remove fourth gear, thrust washer and front bearing.
--Remove second gear from shaft. Remove first gear, thrust washer, rear bearing, oil seal sleeve.
--Remove coupling, connector, and third gear from output shaft.
--Inspect, repair, or replace all parts.
--Press output shaft front bearing on output shaft.
--Place third gear, first, and third gear connector and coupling, and first gear and thrust washer on rear of shaft.
--Press the rear bearing and oil seal sleeve on the output shaft.

To disassemble and assemble countershaft:

--Remove countershaft front bearing cup from transmission housing.
--Pull countershaft rear bearing and oil sleeve off.
--Pull countershaft fourth gear, second, and fourth gear connector and coupling off. Slide countershaft second gear off.
--Inspect, repair, or replace parts.
--Install front bearing cup in transmission housing.

--Install in order on countershaft: second gear, second and fourth gear connector and coupling, countershaft fourth and drive gear. Press on countershaft front bearing and oil seal sleeve.

22. Check output shaft preload with a cord and pull acale. (Preload should be checked when; lower gear forks are in neutral, top gear forks are not yet installed, and the gears and bearings are lightly oiled.) Add or remove shims as required to provide specified preload. Remove output shaft from transmission case and begin complete reassembly. Lubricate all gears and bearings before installing in case. Install new O-ring and snap ring on reverse idler shaft.
23. Reassemble all parts according to operator's service manual until constant mesh transmission is in working order.

LEARNING ACTIVITIES:

1. Read pages 3-3 to 3-4 and 3-12 to 3-13, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

2. Read the disassembly and reassembly procedures for the transmission in the I&T Shop Manual or the manufacturer's service manual.

3. Complete the following questions:

   A. What is another name for a constant mesh transmission?
   B. Explain how a constant mesh transmission works.
   C. What are five things to look for when doing general maintenance?

4. Using Farm Tractor Tune-Up and Service Specifications, AAVIM, determine the type, grade, and quantity of transmission fluid needed.

5. Service the constant mesh transmission on the designated tractor. Follow the procedure in the Performance Guide.

SUPPLEMENTAL READING: 1. Tractor Transmission, American Association for Agricultural Engineering and Vocational Agricultural, Athens, Ga.

CRITERION EVALUATION: All parts will be clean and reassembled correctly with no damage to any parts. They will be properly torqued, lubricated and functioning to manufacturer's specifications. Disassembly and reassembly will be performed in the order outlined by the manufacturer and according to specifications.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING POWERTRAIN

COMPETENCY: Service power-shift transmission

PERFORMANCE OBJECTIVE: Given the manufacturer's service manual, solvents, oil, replacement parts, necessary tools and equipment, service a power-shift transmission.

PERFORMANCE GUIDE:

1. Remove transmission from tractor according to directions in service manual for specific tractor.
2. For general maintenance: clean parts and make oil change.
3. To prevent serious problems:
   --Inspect gear teeth for excessive wear or breaks. Replace as needed.
   --Inspect for worn bearings. Replace as needed.
   --Inspect for defective or plugged transmission oil lines and passages in shaft. Replace or repair as needed.
   --Inspect for broken or distorted shifter detent springs and defective detent balls. Replace as needed.
   --Inspect for worn splines. Replace as needed.
4. Reassemble all parts. Replace transmission according to manufacturer's instructions and specifications.

LEARNING ACTIVITIES:

1. Read pages 3-5 to 3-9 and 3-12 to 3-13, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

2. Study the section on disassembly and reassembly of a power-shift transmission in the I&T Shop Manual or manufacturer's service manual for the designated tractor.

3. Complete the following questions:

   A. What is the difference between a power shift (synchromesh) and a collar-shift transmission?
   B. What is a synchronizer? What are four common types and how do they function?
   C. Explain how a synchromesh transmission works.
   D. List five things to look for when doing general maintenance on a synchromesh transmission.

4. Check Farm Tractor Tune-Up and Service Specifications, AAVIM, for grade, type, and quantity of transmission gear oil needed for the designated tractor.

5. Service power-shift transmission on designated tractor.

SUPPLEMENTAL READING: 1. Tractor Transmissions, American Association for Agricultural Engineering and Vocational Agriculture, Athens, Ga.

CRITERION EVALUATION: All parts disassembled and reassembled will meet specifications given in service manual. All excessively worn or defective parts will be replaced.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING POWERTRAIN

COMPETENCY: Service sliding-gear transmission

PERFORMANCE OBJECTIVE: Given the manufacturer's service manual, oil, needed replacement parts, the tools and equipment stated in the service manual, service a sliding-gear transmission on designated tractor.

PERFORMANCE GUIDE:

1. Remove transmission according to directions in service manual for specific tractor and type of transmission.
2. For general maintenance, clean all parts, and make oil change.
3. To prevent damages to tractor later:
   --Inspect gear teeth for excessive wear and breaks. Replace as needed.
   --Inspect for worn bearings. Replace as needed.
   --Inspect for defective or plugged transmission oil lines or passages in shaft. Replace or repair as needed.
   --Inspect for broken or distorted shifter detent springs or defective detent balls. Replace as needed.
4. Reassemble all parts, and replace transmission according to manufacturer's instructions and specifications.

LEARNING ACTIVITIES:

1. Read pages 3-1 to 3-3 and 3-11 to 3-13, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

2. Study the section on disassembly and reassembly of transmissions in the I&T Shop Manual or manufacturer's service manual.

3. Answer the following questions:

   A. Define the term "sliding gear" transmission.
   B. What are the two basic designs?
   C. What are the differences in the two basic designs?
   D. What are five things to look for when doing general maintenance on a sliding-gear transmission?

4. Check Farm Tractor Tune-Up and Service Specifications for the proper grade, type, and quantity of transmission gear oil needed for the designated tractor.

5. Using the Performance Guide, service the sliding-gear transmission on the designated tractor.

SUPPLEMENTAL READING: 1. Tractor Transmissions, American Association for Agricultural Engineering and Vocational Agriculture, Athens, Ga.

CRITERION EVALUATION: Disassembly and reassembly will follow manufacturer's instructions. All parts will be clean and operate to manufacturer's specifications. Replacement parts will be installed where necessary.

SECTION XV Maintaining and Servicing Differentials

1. Correct Adjustment of Ring Gear and Pinion 245

2. Preload Bearings 246

3. Repair Differentials 247

4. Replace Brake and Axle Seals and Gaskets 250

5. Service Differential Locks (Mechanical, Hydraulic) 251

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING DIFFERENTIALS

COMPETENCY: Correct adjustment of ring gear and pinion

PERFORMANCE OBJECTIVE: Given a service manual for the tractor being used, a complete set of mechanic's tools, and a dial indicator, correct the adjustment of the ring gear and pinion on the differentials.

PERFORMANCE GUIDE:

1. Following the instructions in the service manual for the tractor in question, remove parts necessary to give access to ring gear and pinion.
2. Using a dial indicator, check the ring gear backlash at several locations on the ring gear.
3. Check readings against manufacturer's specifications, and adjust ring gear and pinion to manufacturer's specifications as shown in the service manual.
4. Reassemble and/or reinstall all parts.

LEARNING ACTIVITIES:

1. Read pages 1-20 to 1-21, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

2. Read the section on ring gear and pinion in the I&T Shop Manual or manufacturer's service manual.

3. Read pages 80-86, Fundamentals of Service-Tractors, Deere and Co., Moline, Ill., 1973.

4. Complete the following questions:

   A. What are three kinds of adjustments that need to be made on the gear train? Explain the importance of adjustments.
   B. Once the gear set is assembled, what are the four steps needed to adjust it?

5. Label the parts of a ring gear and pinion on the diagram provided by your instructor.

6. Correct the adjustment of the ring gear and pinion on the designated tractor using the Performance Guide, I&T Shop Manual, and the manufacturer's service manual.

CRITERION EVALUATION: The adjustments will be to manufacturer's specifications, all parts will be reassembled and installed according to manufacturer's directions, and there will be no damage to any parts.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING DIFFERENTIALS

COMPETENCY: Preload bearings on the axle shaft.

PERFORMANCE OBJECTIVE: Using a designated tractor and the service manual, a set of spacers, and all necessary tools, preload the bearings on the axle shaft.

PERFORMANCE GUIDE:

1. Follow manufacturer's instructions in the service manual to reach axle shaft bearings.
2. Using a .089 in (2.261 mm) spacer, fit spacer, retaining washer and tighten the axle shaft bolt(s).
3. Set up a dial indicator with an extended plunger on top of the axle shaft bolt(s).
4. Set the dial indicator at zero and lift the axle housing. (This action will result in a dial indicator reading which shows the free movement between the inner and outer cone and roller assembly and their cups.)
5. To determine correct bearing preload, the reading obtained is subtracted from the spacer size fitted (i.e. .089 or 2.261 mm).
6. Check manufacturer's specifications and select and install the correct spacer.
7. Reassemble all parts following the manufacturer's instructions in the service manual.

LEARNING ACTIVITIES:

1. Read page 8-7, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972., and complete the following questions:

   A. What does it mean to "Preload Bearings?"
   B. Preloading is normally measured in inch-pounds of starting torque (True-False). Why?
   C. What are two methods of measuring rolling torque?
   D. What will happen if the bearings are not installed correctly?

2. Read the section on axle bearings in the I&T Shop Manual or manufacturer's service manual before preloading the axle bearing.

3. With the help of the Performance Guide or the manufacturer's service manual, preload the bearings on the axle of the designated tractor.

SUPPLEMENTAL READING:

1. Fundamentals of Service-Bearings and Seals, Deere and Co., Moline, Ill., 1972.

CRITERION EVALUATION: The correct spacer as outlined in the service manual will be used, the dial indicator reading will be the same as the instructor's, and all parts will be reassembled according to manufacturer's instructions with no parts damaged.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING DIFFERENTIALS

COMPETENCY: Repair differentials

PERFORMANCE OBJECTIVE: Given the service manual for the tractor to be repaired and the necessary tools and equipment, repair the differentials.

PERFORMANCE GUIDE: To repair differentials on a tractor you must have the service manual for the make and model of the tractor. The following instructions are for an Allis-Chalmers tractor.

1. Drain the oil from the transmission, differential and final drive compartments.
2. Support transmission housing to permit removal of rear wheels.
3. Remove:
   --seat
   --hydraulic control valve
   --transmission cover from top of differential and final drive compartments
   --rear power take-off shaft and lift shaft housing
   --rear wheels and rear axle
   --brake assemblies
   --final drive pinion shafts
   --differential bearing carriers at both sides of housing (keep shims in the same order and with the correct carrier to make reassembly easier).
   --differential assembly from top of housing
   --lock pin retaining the pinion shaft (drive lock pin out by inserting punch through ring gear side of assembly)
   --side pinion and thrust washers
   --the two side gears and thrust washers
4. Pull bearing cones from differential case if replacement is needed.
5. Pull bearing cups from bearing carriers if replacement is needed.
6. Remove oil seals from the bearing carriers.
7. The rivet retaining ring gear will have to be cut and driven out if the ring gear of differential case is to be replaced.
8. Check all parts for wear and replace parts where necessary.
9. Check manufacturer's service manual for differential installation for specific model.

10. Install:
    --ring gear to differential case with bolt set 236962
    --bolts through ring gear with nuts on outer side of mounting flange
    --both side gears and thrust washers through opening in differential case
    --pinion gears and thrust washers spacing them equal at each side of case, rolling them around until they are in line with the pinion shaft bore in differential case
    --pinion shaft with hole at end of shaft in line with lock pin hole in case
    --lock pin (peen edge of hole to retain pin)
    --bearing cones at each side of differential case (larger diameter of bearing toward case)
    --bearing cups in bearing carriers (larger inside diameter of cup inward)
    --oil seals in bearing carriers (lip of seal toward differential assembly)
    --differential assembly into transmission housing with rear gear on right hand side
    --bearing carriers to transmission housing (use shims that were removed with each carrier)
11. Use No. 3 permatex on pilot area of the bearing carriers and on threads of retaining cap screws.
12. Tighten retaining cap screws 45-50 ft. lbs torque.
13. Reassemble remaining parts in the reverse order removed, checking service manual for specifications.

LEARNING ACTIVITIES:

1. Read Chapter 7. Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

2. Read the section on differentials in the I&T Shop Manual or manufacturer's service manual

3. Complete the following questions:

    A. What are two jobs that a differential does?
    B. What is normally adjusted in the differential?
    C. What are 4 common failures of differentials and the possible causes?

4. With the help of the service manual, repair the differentials on the designated tractors.

SUPPLEMENTAL READING: 1. Pages 1-20 to 1-21, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

CRITERION EVALUATION: Disassembly and reassembly will be in the order specified in the service manual. All parts will be clean and lubricated when specified. All parts will be torqued to specifications.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING DIFFERENTIALS

COMPETENCY: Replace brake and axle seals and gaskets

PERFORMANCE OBJECTIVE: Using a designated tractor and the manufacturer's service manual, new gaskets and seals, and the necessary tools, equipment, and supplies, replace the brake and axle seals and gaskets.

PERFORMANCE GUIDE:

1. Follow instructions in manufacturer's service manual to reach seals and gaskets.
2. Remove old seals and gaskets.
3. Clean seal and gasket seats thoroughly without removing any metal.
4. Install new seals and gaskets making sure each is properly seated.
5. Reassemble according to manufacturer's instructions and specifications.

LEARNING ACTIVITIES:

1. Consult the I & T Shop Service Manual for any additional information that may be needed in order to replace the brake and axle seals and gaskets.

2. With the help of the performance guide, replace the brake and axle seals and gaskets on the designated tractor.

SUPPLEMENTAL READINGS:

1. Fundamentals of Service - Bearings and Seals, Deere and Co., Moline, Ill., 1972.

CRITERION EVALUATION: All seals will meet specifications, will be correctly installed, will show no signs of leaks. All parts will be reassembled to manufacturer's instructions and specifications, and there will be no damage to any parts.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING DIFFERENTIALS

COMPETENCY: Service differential locks (mechanical, hydraulic)

PERFORMANCE OBJECTIVE: Using a designated tractor and the service manual, the necessary tools, supplies, and replacement parts, service the differential locks (mechanical and hydraulic).

PERFORMANCE GUIDE: Refer to manufacturer's service manual for specific instructions for the tractor being serviced.

1. Differential lock adjustment:
   --Remove pins securing operating lever to operating rod.
   --Depress lever until operating fork contacts the differential lock sliding coupling.
   --Loosen stop screw lock nut and rotate the differential lock stop screw clockwise until it contacts the bottom of the slot in the differential lock fork. Contact point is observed when operating lever begins to move.
   --Turn adjusting screw back one quarter turn and lighten lock nut.
   --Depress the operating lever, with foot pedal resting on the platform, until the differential coupling is fully engaged.
   --Loosen lock nut and adjust length of operating rod until clevis pin can be inserted to connect the operating rod to the lever without compressing the spring in the operating rod.
   --Remove clevis pin and shorten operating rod by one turn; reset clevis pin.
   --Tighten lock nut and fit the cotter pin in place.
2. Refer to manufacturer's service manual to overhaul differential lock assembly:
   --Remove left hand wheel and fender.
   --Disconnect electrical wiring and brake linkage to gain access to rear axle.
   --Drain oil from rear axle center housing.
   --Disassemble according to instructions in service manual.
   --Inspect and clean all parts.
   --Repair or replace parts where necessary following instructions in the service manual.
   --Assemble all parts.
   --Replace oil in rear axle center housing.
   --Connect electrical wiring and brake linkage.
   --Replace wheel and fender.

LEARNING ACTIVITIES:

1. Read pages 7-2 to 7-4, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

2. Read the section on differentials in the I&T Shop Manual or manufacturer's service manual.

3. Complete the following questions:

   A. What is the function of a differential lock?
   B. What are three types of differential locks?
   C. Briefly describe how each of them works and how they differ from one another.
   D. Which type of differential does not allow the inside wheel on a turn to slow down-only the outside wheel to speed up?

4. Check the Farm Tractor Tune-Up and Service Specifications publication by AAVIM for the correct gear oil for your tractor's differential.

5. With the help of the Performance Guide and service manual, service the differential locks on the assigned tractor.

CRITERION EVALUATION: All worn or damaged parts will be repaired or replaced according to manufacturer's specifications. All parts will be clean on visual inspection. The differential and differential locks will be disassembled and reassembled in the order specified in the service manual.

SECTION XVI Maintaining and Servicing Final Drive

1. Adjust Chain Drive in Final Drive 253

2. Adjust End Play in Final Drive 255

3. Preload and Install Bearings in Final Drive 256

4. Service Final Drives 258

5. Service Inboard and Outboard Mounted Planetary Drives 260

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING FINAL DRIVE

COMPETENCY: Adjust chain drive in final drive

PERFORMANCE OBJECTIVE: Given the manufacturer's service manual, a jack and blocks, and the necessary tools, adjust the chain drive in the final drive on the designated tractor.

PERFORMANCE GUIDE:

NOTE: Chain drives have a tendency to loosen due to wear. Some chain drives operate in an oil bath to reduce wear. On most tractors ways to take up the chain slack are provided. Check manufacturer's service manual for specific instructions.

1. Jack up tractor and block wheels. Set parking brake.
2. Following instructions in service manual, remove all parts necessary to reach chain drive.
3. Adjust tension to manufacturer's specifications.
   a. If an eccentric bearing is provided in axle housing, take up chain slack by rotating bearing housing. (On some tractors the entire axle housing can be moved for chain adjustment.
   b. An alternate way of adjusting chain is use of tightener sprocket on slack side of chain. (NOTE: When the machine is reversed, more force is exerted to the slack side of the chain and through the sprocket.)
4. Reassemble any parts removed. Remove blocks and jack.

LEARNING ACTIVITIES:

1. Read pages 8-6 to 8-8, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

2. Read the section on final drive adjustment in the I&T Shop Manual for specific instructions on the proper procedure for adjusting the tension on the drive chain.

3. Using the Performance Guide and the I&T Shop Manual, adjust the chain drive on the designated tractor.

SUPPLEMENTAL READING:

1. Page 137, Fundamentals of Machine Operation-Preventive Maintenance, Deere and Co., Moline, Ill., 1973.

CRITERION EVALUATION: The tension on the chain drive will be to manufacturer's specifications.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING FINAL DRIVE

COMPETENCY: Adjust end play in final drive

PERFORMANCE OBJECTIVE: Using a designated tractor and the manufacturer's service manual, a dial indicator, shims and the necessary tools, adjust the end play in the final drive.

PERFORMANCE GUIDE:

1. Remove all parts necessary to reach gears and shafts in final drive following directions in the manufacturer's service manual.
2. To check the end play, mount a dial indicator against the side of a gear or the end of a shaft. The gear or shaft is then pried in both directions. Note the readings. The difference between the two readings is the end play.
3. Adjust the end play with shims or adjusting nuts according to manufacturer's recommendation, and adjust to specifications. (NOTE: Too much end play is caused by too little (or no) bearing support for the thrust produced by the gears rotating. Consequently, preloading of the gear drives may take up the slack and load the bearings.)
4. Reassemble.

LEARNING ACTIVITIES:

1. Read pages 8-7 to 8-8, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

2. Answer the following questions:

   A. Some drive axles call for the axle shaft to have a slight amount of end play. When properly adjusted, what would the end movement be in most cases.
   B. What should you use to obtain the proper end play?

3. Read the section on final drive adjustment in the I&T Shop Manual for the assigned tractor.

4. Adjust the end play in the final drive on the assigned tractor.

CRITERION EVALUATION: All parts will be disassembled and reassembled according to manufacturer's instructions, and the end play will be within the limits specified in the service manual.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING FINAL DRIVE

COMPETENCY: Preload and install bearings in final drive

PERFORMANCE OBJECTIVE: Given the manufacturer's service manual, correct tools and equipment, solvent, grease and any needed replacement parts, preload and install bearings in the final drive on the designated tractor.

PERFORMANCE GUIDE: NOTE: There are two common types of wheel bearing assemblies - (1) spindle-type wheel and bearings and (2) axle-type wheel and bearings. Check service manual for type and instructions.

1. Spindle-type:

--Block other wheels, set parking brake. Raise tractor with jack so wheel is off ground.
--Clean dirt from wheel and hubcap.
--Remove hubcap, cotter pin, adjusting nut, thrust washer and outer bearing.
--Pull wheel off spindle holding hand behind wheel to catch inner bearing. (If grease seal cannot be removed, turn wheel over with inner bearing down.)
--Place clean cloth or container under hub to catch bearing and seal when they fall off. Use a brass drift punch or wooden dowel and gently tap bearing cone from the hub.
--With a brush clean grease deposits from bearing in container of solvent (or, if bearing and grease seal are still in place, with brushe and solvent).
--Clean bearing cup, hub, cap, and spindle.
--Remove solvent and dry with compressed air or clean cloth. (Do not spin dry bearing and do not use air which contains moisture thus causing rust.)
--Examine bearings for damage, wear, rust, or corrosion. Replace defective bearings, if any.
--Examine inner bearing, grease seals, and retainers. Replace any defective parts.

1a. Repacking and assembling bearings:

--Use multi-purpose grease or wheelbearing grease as specified in service manual. Place a small quantity of grease in palm of hand and push grease into bearing, rotating bearing until grease is worked in thoroughly. If inner bearing is left on spindle, apply thick coat of grease to outer portions and

with clean cloth or bearing packer, force grease into bearing.
--Apply coating of grease to inside of hub. (Do not fill entire cavity unless specified in service manual.)
--Reassemble wheel bearings in reverse order of disassembly.
--Install wheel and adjust wheel bearings according to manufacturer's specifications and instructions.

2. Axle-type:
--Jack up machine and block wheels. Set parking brake.
--Clean dirt from wheel and hub area.
--Remove screws from bearing lock plates and bend lock plates away from axle nuts.
--Loosen axle nuts and remove dust shields.
--Remove axle nut and outer washers.
--Remove wheel.
--Disassemble axle, seals, bearings, and any spacers and nuts remaining.
--Clean, repack, and assemble bearing.
--Reassemble all parts and adjust to manufacturer's specifications.

LEARNING ACTIVITIES:

1. Read pages 8-6 to 8-7, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972.

2. Read the section on servicing final drives in the I&T Shop Manual.

3. Complet the Self-Test "Servicing Bearings in the Final Drive."

4. Using the Performance Guide and the I&T Shop Manual, preload and install bearings in the final drive on the designated tractor.

CRITERION EVALUATION: The disassembly and assembly will follow manufacturer's directions and specifications. All parts will be clean and undamaged.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING FINAL DRIVE

COMPETENCY: Service final drives

PERFORMANCE OBJECTIVE: Given the service manual, proper tools, cleaning solution, lubrications, and replacement parts, service three types of final drive on the designated tractor.

PERFORMANCE GUIDE: NOTE: There are three major types of final drive systems - pinion, planetary, and chain. Check manufacturer's service manual to determine the type of final drive for the tractor to be serviced.

1. Service pinion drive system. NOTE: There are two types of pinion and gear reductions - (a) a pinion drive located in the differential case, and (b) a pinion drive located on the outer ends of final drives.
   a. Pinion drive inside differential case:
      --Following instructions in manufacturer's service manual, disassemble all parts necessary to reach pinion drive.
      --Remove pinion gears, clean thoroughly, checking for wear or damage. Repair or replace parts where necessary.
      --Reassemble pinion gears and torque to manufacturer's specifications.
      --Reassemble gears in differential case to manufacturer's instructions and specifications.
   b. Pinion drive on outer ends of final drives:
      --Following instructions in service manual, remove all parts necessary to reach case or housing for pinion gears.
      --Detach gear housing from differential and wheels.
      --Remove pinion gear and spur gear from housing, discarding old oil. Clean, inspect for damage, and repair or replace parts if necessary.
      --Reassemble gears according to manufacturer's instructions and specifications and replace oil.
      --Reassemble gear housing and all other parts removed following directions in service manual.
2. Service planetary drive syster. (See Competency Sheet - "Service inboard and outboard mounted planetary drives.")

3. Service chain drives.
   --Following manufacturer's instructions in service manual, remove all parts necessary to reach chain drive.
   --Clean and inspect roller chain, final drive shaft and gear, axle housing and gear. Repair or replace worn or defective parts.
   --Lubricate.
   --Adjust chain drive to specifications.
   --Reassemble following manufacturer's instructions.

LEARNING ACTIVITIES:

1. Read pages 8-3 to 8-7, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972, and answer the following questions:

   A. What are three major types of final drive?
   B. What are the major advantages of each?
   C. What are two types of pinion and gear reductions? What makes them different?
   D. What are three key points to remember when diagnosing final drive failures?

2. Read the section on final drives in the I&T Shop Manual or the manufacturer's service manual for the designated tractor.

3. Service the final drive on the designated tractor. Follow the procedure outlined in the Performance Guide and the I&T Shop Manual.

CRITERION EVALUATION: All parts will be clean and lubricated. Disassembly and reassembly will follow manufacturer's recommendations. All parts will be torques according to manufacturer's specifications. There will be no damage to any parts.

STUDENT COMPETENCY SHEET

UNIT: MAINTAINING AND SERVICING FINAL DRIVE

COMPETENCY: Service inboard and outboard mounted planetary drives.

PERFORMANCE OBJECTIVE: Given the manufacturer's service manual, the needed tools and replacement parts, service inboard and outboard mounted planetary drives.

PERFORMANCE GUIDE:

NOTE: The planetary gear set may be located next to the differential or at the outer ends of the final drive. Both types operate in the same manner.

1. Refer to manufacturer's service manual for make, model, and year of tractor for disassembly instructions.
2. Disassemble rear axle shaft assembly following steps outlined in service manual.
3. Disassemble planetary drive following steps outlined in service manual.
4. Thoroughly clean and inspect all parts and replace parts which are worn or damaged.
   --If necessary, install new inner bearing cup.
   --If necessary, install new planetary ring following directions in service manual.
5. Reassemble planetary drive following steps outlined in service manual.
6. Reassemble rear axle shaft assembly according to manufacturer's specifications.

LEARNING ACTIVITIES:

1. Read pages 8-4 to 8-5, Fundamentals of Service-Power Trains, Deere and Co., Moline, Ill., 1972, and complete the following questions:

   A. What is the main difference between the planetary gear reduction system and the pinion type?
   B. Planetary systems are more durable under heavy load than the pinion type. (True-False) Why?
   C. The planetary final drive contains a sun gear that is an integral part of the final drive shaft. (True-False) Why?
   D. What is the difference between the inboard and outboard planetary drive? Describe how each one works.
   E. What are the three basic parts of the planetary drive system?

2. Identify a tractor with an inboard planetary drive and one with an outboard planetary drive.

3. Read the section on final drives in the I&T Shop Manual or the manufacturer's service manual before you begin servicing a planetary drive system.

4. Service the inboard and outboard mounted planetary drives on the designated tractor(s).

CRITERION EVALUATION: All parts will be thoroughly cleaned. Disassembly and reassembly will be in order of manufacturer's instructions. There will be no damage to any part.